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Chemical/Biological Agent Resistance Test (CBART) Test Fixture System Verification and Analytical Monitioring System Development (CBART Phase III)Final Report

5a. CONTRACT NUMBER

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W911NF-09-C-0053

5c. PROGRAM ELEMENT NUMBER
306033

6. AUTHORS
Adam Judd, Brian Blackstone, Bruce McVeety

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES AND ADDRESSES
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U.S. Army Research Office
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14. ABSTRACT
The objective of this project is to complete CBART test fixture assembly, analytical monitoring system development, and verification testing. Battelle used a systems integration approach to manage the CBART development efforts. At various stages of the project, Battelle coordinated directly with the stakeholders to ensure they were up-to-date and that their concerns were considered and addressed. Battelle generated a systems engineering Vee diagram for CBART along with the stakeholder contact points that occurred to date and

15. SUBJECT TERMS
CBART, permeation, AVLAG, protective materials, testing, chemical warfare agents

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Adam Judd
UU	UU	UU	UU		19b. TELEPHONE NUMBER: 410-306-8649

Report Title

Chemical/Biological Agent Resistance Test (CBART)
Test Fixture System Verification and Analytical
Monitioring System Development (CBART Phase III)Final Report

ABSTRACT

The objective of this project is to complete CBART test fixture assembly, analytical monitoring system development, and verification testing. Battelle used a systems integration approach to manage the CBART development efforts. At various stages of the project, Battelle coordinated directly with the stakeholders to ensure they were up-to-date and that their concerns were considered and addressed. Battelle generated a systems engineering Vee diagram for CBART along with the stakeholder contact points that occurred to date and distributed it to stakeholders.

List of papers submitted or published that acknowledge ARO support during this reporting period. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Number of Papers published in peer-reviewed journals: 0.00

(b) Papers published in non-peer-reviewed journals or in conference proceedings (N/A for none)

Number of Papers published in non peer-reviewed journals: 0.00

(c) Presentations

Chemical/Biological Agent Resistance Test (CBART) Sampling Train
and Near Real-Time Analytical System
Bruce D. McVeety, Shawn M. Shumaker, James C. Peterson, and Zachary E. Duerr.
Battelle Hazardous Material Research Center, 505 King Avenue, Columbus, OH

Chemical barrier materials are routinely challenged with chemical warfare agents (CWAs) to evaluate their protective capabilities. Currently, permeation testing of material swatches with chemical agents is conducted using text fixtures based on the Aerosol-Vapor-Liquid Assessment Group (AVLAG) test cell and Test Operation Procedure (TOP) 8-2-501 methodology. Recognized limitations of this test methodology have led to an effort to design a new Chemical/Biological Agent Resistance Test (CBART) test cell and fixture that 1) more accurately represents real world field conditions, 2) uses a single test cell configuration and air flow pattern for air-permeable, semipermeable, and impermeable materials, and 3) permits a greater range of environmental variables (temperature, humidity, wind speed, and atmospheric pressure) for barrier material evaluation. In addition to the fixture, a new automated sample train coupled with a near real-time (NRT) analytical system is under developed. The Stakeholder specified design requirements for the analytical system are shown Table 1. The design intent is to eliminate manual sampling and provide a higher sampling frequency, while maintaining/improving both analytical sensitivity and precision. The design intent is to allow the determination of chemical breakthrough profiles to understand better the mechanisms or chemical agent barrier failure, with the goal of increasing the information generated during permeation trials, reducing the cost of analysis, and maintaining the high sample throughput necessary for barrier qualification testing.

Number of Presentations: 1.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts): 0

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts): 0

(d) Manuscripts

Number of Manuscripts: 0.00

Patents Submitted

Patents Awarded

Awards

None

Graduate Students

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Post Doctorates

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

NAME	PERCENT_SUPPORTED	National Academy Member
Dr. Bruce McVeety	0.50	No
Martin Zilka	0.40	No
Ray Zaborski	0.70	No
Adam Judd	0.15	No
Brian Blackstone	0.40	No
John Coll	0.70	No
Shawn Shumaker	0.25	No
FTE Equivalent:	**3.10**	
Total Number:	**7**	

Names of Under Graduate students supported

NAME	PERCENT SUPPORTED

FTE Equivalent:

Total Number:

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period:	0.00
The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:.....	0.00
The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:.....	0.00
Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):	0.00
Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:	0.00
The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense	0.00
The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:	0.00

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PHDs

NAME

Total Number:

Names of other research staff

NAME	PERCENT SUPPORTED

FTE Equivalent:

Total Number:

Sub Contractors (DD882)

1 a. Dublin Technical Systems Inc

1 b. 6199 SHAMROCK COURT

Dublin Ohio 43016

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Electrical Process/Control Design and Construction

Sub Contract Award Date (f-1): 4/4/2009 12:00:00AM

Sub Contract Est Completion Date(f-2): 10/31/2010 12:00:00AM

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1 a. Sauer Group Inc.

1 b. 1801 Lone Eagle Street

Columbus Ohio 43228

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Installation trades personnel

Sub Contract Award Date (f-1): 5/7/2009 12:00:00AM

Sub Contract Est Completion Date(f-2): 10/31/2010 12:00:00AM

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1 a. HAWA Incorportated

1 b. 980 Old Henderson Rd

Columbus Ohio 43220

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Laboratory integration of test fixture and generation of facility drawings.

Sub Contract Award Date (f-1): 5/13/2009 12:00:00AM

Sub Contract Est Completion Date(f-2): 6/30/2010 12:00:00AM

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1 a. KIN-TEK™ Laboratories, Inc

1 b. 504 Laurel

La Marque TX 77568

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Development of custom analytical equipment (Gas Standards Generator)

Sub Contract Award Date (f-1): 8/19/2009 12:00:00AM

Sub Contract Est Completion Date(f-2): 1/31/2010 12:00:00AM

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1 a. QA GROUP LLC

1 b. 363 VINTAGE PARK DRIVE

Foster City CA 94404

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Custom analytical equipment (24/7 Markes System and GC/MS) and on site training.

Sub Contract Award Date (f-1): 8/19/2009 12:00:00AM

Sub Contract Est Completion Date(f-2): 10/31/2010 12:00:00AM

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1 a. Myers Machinery Movers, Inc

1 b. 2210 Hardy Parkway St.

Columbus Ohio 43123

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Transport of CBART Skid, Blower, Electric Control Panel, and Blower from subcontractor to HMR

Sub Contract Award Date (f-1): 10/2/2009 12:00:00AM

Sub Contract Est Completion Date(f-2): 6/30/2010 12:00:00AM

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1 a. BRUNER CORPORATION

1 b. P O BOX 4050
3637 LACON ROAD

HILLIARD Ohio 43026-2573

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Pipe fitter installation trades personnel.

Sub Contract Award Date (f-1): 10/21/2009 12:00:00AM

Sub Contract Est Completion Date(f-2): 1/31/2011 12:00:00AM

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1 a. Thermo Fisher Scientific

1 b. 2000 Park Lane

Pittsburgh, PA 15275

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Analytical Balanace For Sample Train

Sub Contract Award Date (f-1): 12/30/2009 12:00:00AM

Sub Contract Est Completion Date(f-2): 3/31/2010 12:00:00AM

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1 a. Mid City Electric Company

1 b. 1099 Sullivant Avenue

Columbus Ohio 43223

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Electrical installation trades personnel

Sub Contract Award Date (f-1): 4/5/2009 12:00:00AM

Sub Contract Est Completion Date(f-2): 9/30/2010 12:00:00AM

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1 a. Process Control Services Inc

1 b. 401 Industrial Drive

Plymouth MI 48170

Sub Contractor Numbers (c):

Patent Clause Number (d-1):

Patent Date (d-2):

Work Description (e): Loop tuning consultant

Sub Contract Award Date (f-1): 12/21/2010 12:00:00AM

Sub Contract Est Completion Date(f-2): 2/15/2011 12:00:00AM

Inventions (DD882)

Scientific Progress

1.1 Objective

The objective of this project was to complete Chemical Biological Agent Resistance Test (CBART) fixture assembly, analytical monitoring system development, and verification testing. The specific objectives that were met, partially met, and not met include:

- Completed the construction of the prototype CBART system
- Completed identifying the components and design of a near real-time (NRT) sampling train
- Completed the construction of the NRT sampling train
- Partially completed shakedown testing of the prototype CBART system
- Partially completed verifying that the CBART fixture meets user safety requirements
- Partially completed integrating the NRT sampling train with the CBART fixture
- Did not complete the verification testing of the NRT sampling train
- Did not complete the system verification test readiness review (TRR)
- Did not complete a series of CBART fixture performance trials to verify the ability of the prototype test fixture to meet system test requirements
- Did not complete documenting the performance of standard reference materials (SRMs) under CBART conditions.

Note: All of the above objectives that have been partially met or not met at this time will be completed through a follow-on contract. Objectives were either partially completed or not completed because the construction and shakedown stages took longer to complete and took more funds than originally estimated. In addition, a number of unplanned moficifcations to the fixture were carried out.

1.2 Approach

Battelle used a systems integration approach to manage the CBART development efforts. At various stages of the project, Battelle coordinated directly with the stakeholders to ensure they were up to date and that their concerns were considered and addressed.

1.3 Performance

Over the course of the two-year project, Battelle concentrated on the following Statement of Work (SOW) Task 4 phases:

- Task 4, Phase IIIA. a. Complete Fabrication of Test System.
- Task 4, Phase IIIA. b. Install CBART Prototype.
- Task 4, Phase IIIA. c. Integrate Subcomponent Items.
- Task 4, Phase IIIA. d. Conduct Shake Down Testing.
- Task 4, Phase IIIB. a. Conduct System Analysis.
- Task 4, Phase IIIB. b. Convene a Peer Review.
- Task 4, Phase IIIB. c. Design Sample Train.
- Task 4, Phase IIIB. d. Develop Interface Control Document.
- Task 4, Phase IIIC. a. Development Plan.
- Task 4, Phase IIIC. b. Construct Sample Train.
- Task 4, Phase IIIE. a. Test Plan Modification.

2.0: SECOND QUARTER FY09 PROGRESS (FEBRUARY 11, 2009 – MARCH 31, 2009)

2.1 Summary of Work Performed

Battelle implemented a system engineering process that was used to facilitate a peer review and gather necessary information to design the CBART sample train. The peer review was held at the Thayer Hotel in West Point, New York.

Battelle held an internal CBART system safety review. This was jointly funded with the previous CBART contract (Contract No.DAAD19-02-D-0001, DO No. 0360, TCN 08-109) and delivered to Defense Threat Reduction Agency (DTRA) as part of the contract closeout. The safety review followed the Department of Defense (DoD) Standard Practice for System Safety (MIL-STD-882D) recommendations for probability, severity, and risk assessment for each scenario. A final report was generated as a result of the system safety review. The results of this report were then used to modify the design and layout of the CBART fixture.

2.2 Detailed Work Performed by SOW Element

Task 4, Phase IIIA. a. Complete Fabrication of Test System. No progress made during this reporting period.

Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4. Phase IIIB. a. Conduct a Systems Analysis. Battelle implemented a system engineering process to review requirements, identify technology gaps/limitations and develop design concepts based on existing methods to meet the requirements for a CBART sampling train/analytical process.

Task 4. Phase IIIB. b. Convene a Peer Review. Battelle worked directly with DTRA Joint Science and Technology Office (JSTO) to identify participants and convene an independent peer review.

1) Attendees consisted of analytical chemistry and permeation testing subject matter experts from academia, government, and industry.
2) Attendees had expertise in chemical agent analysis, agent properties, sample collection, and existing sampling hardware and methods.
3) Battelle developed a representative scenario to estimate potential below swatch agent concentration for determining analytical sensitivity requirements. The scenario was based on typical collective protection equipment and protection scenarios versus nerve agent VX (VX). Peer review panel members used the requirements developed from the model for the basis of their recommendations.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a-d. Prototype Analytical System Construction and Verification. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

2.3 Other Key Events

Battelle and subcontractors removed all existing electrical, mechanical, ventillation, and hoods from an existing lab to make room for the CBART fixture (funded by Battelle).

Battelle began procuring long lead items such as mass flow controllers (MFCs) and air flow valves.

3.0: THIRD QUARTER FY09 PROGRESS (APRIL 1, 2009 – JUNE 30, 2009)

3.1 Summary of Work Performed

All three CBART hoods (one 6 ft to house the blower, one 8 ft to house the analytical system, and one 12 ft to house the CBART fixture/cells) were delivered and installed into the modified Battelle laboratory (funded by Battelle).

Battelle dispersed the CBART draft peer review sample train report, received and responded to comments, finalized, and sent it back to the client.

The Battelle Program Plan (internal document) was written and finalized. The Battelle test team began addressing the

verification test plan comments from the first version. These comments were incorporated into the second version. Battelle began using the final peer review panel report to detail the design of the sample train. In addition, Battelle began working on preliminary computer aided design (CAD) drawings of the sample train and the sample train development plan.

Due to the growing complexity of the fixture and to make sure the system was “user friendly”, three rudimentary test cell mock-ups were built to allow the test team to refine the design of the fixture.

The Army Research Office (ARO) accepted and fully funded the contract. Work prior to this quarter was funded via pre-award funds.

Battelle prepared for and hosted a CBART stakeholder update. The update was held via teleconference and focused on the contract status, schedule, current progress, risks to the project, and the projected path forward. The meeting was also used to discuss the status of the sample train design.

3.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA. a. Complete Fabrication of Test System. Battelle continued with design and layout of the CBART fixture and incorporating results of the safety review report into the design of the fixture.
Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4. Phase IIIB. b. Convene a Peer Review. Battelle worked directly with DTRA JSTO to identify participants and convene an independent peer review. The peer review panel identified existing methodology and equipment suitable for use in NRT sampling within the CBART breadboard. Panel members identified advantages and disadvantages of the hardware and processes recommended. The panel compiled the information into an overall recommendation for implementation into CBART that included suggestions for additional data gathering and a recommended path forward.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a-d. Prototype Analytical System Construction and Verification. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

3.3 Other Key Events

Battelle delivered a spreadsheet to ARO and DTRA outlining the cost issues within the project. This spreadsheet covered cost impact for current scope, potential scope growth that resulted from the stakeholder review of the verification test plan (first version), and potential scope growth associated with the peer-panel recommended sample train.

4.0: FOURTH QUARTER FY09 PROGRESS (JULY 1, 2009 – SEPTEMBER 30, 2009)

4.1 Summary of Work Performed

Battelle finalized the CBART fixture design and layout in AutoCAD. The design of the dionized (DI) water system that will feed the CBART fixture was finalized as well as the electrical process/control design of the CBART fixture. Battelle's piping subcontractor, Bruner Corporation, began and completed fabrication of the CBART fixture. Once complete, the fixture was dissasembled, cut up into pieces, and shipped to Silco-Tek for coating. Due to the weight of all of the equipment and piping associated with the main fixture, an enhanced support structure was designed and added to the fixture.

Battelle prepared and submitted a proposal to capture add-on costs of ~$875,000. Funding was received. Part of this effort included a modification of the current contract to re-program funds in the amount of $139,217 in labor funding to construct the analytical sampling train subcomponent of the CBART fixture.

Battelle finalized the design of the analytical hood configuration with sample train. In addition, Battelle completed a preliminary CAD of the CBART sample train and a sample train development plan. Battelle ordered all analytical equipment associated with the sample train, including custom software to control purge air MFC and a custom gas chromatograph (GC) oven and began to receive the first pieces of the sample train (MSD/DS, 7890A Series GC, and Markes System).

Battelle's electrical subcontractor, Dublin Technical Systems, began design and assembly/wiring of the main CBART electical panel. Battelle received additional significant pieces of equipment to include the blower, vacuum pump, and the first Creare cell. In addition, all remaining long lead items were received including the Keystone valves.

4.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA. a. Complete Fabrication of Test System. Battelle finalized the design and layout of the CBART fixture. The finalized design met all safety, ergonomic and operational requirements.

Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4. Phase IIIB. c. Design Sample Train. Using the results of the peer review and supporting studies, Battelle completed a preliminary CAD design of the CBART sample train. Note, Battelle continued to update the CAD package throughout the year.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4. Phase IIIC. a. Development Plan. Battelle prepared a development plan which included a summary of the planned activities in building the automated NRT analytical system. The plan included an outline of the verification procedure for testing the system following the build, and the selection and rationale for a model challenge chemical to be used for development and verification.

Task 4, Phase IIIC. b. Construct Sample Train. No progress made during this reporting period.

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

4.3 Other Key Events

Battelle and its subcontractors completed all laboratory modifications, to include hood air flow balance (funded by Battelle).

Select members of the Battelle test team traveled to Creare to witness a demonstration of the CBART spiking wand.

5.0: FIRST QUARTER FY10 PROGRESS (OCTOBER 1, 2009 – DECEMBER 31, 2009)

5.1 Summary of Work Performed

Battelle finalized completion of addressing verification test plan comments and issued a second draft to the client. Battelle finalized the CBART support structure design and the mechanical subcontractor (Bruner Corporation) completed the build. Bruner received coated pieces from Silco-Tek and began the reassembly process (80% complete). During the reassembly process, it was determined that all piping coated by Silco-Tek had not been properly cleaned before being shipped. The entire skid was completely dissembled, all piping was cleaned by hand, and then the entire skid was reassembled. In order to reassemble the skid, all of the gaskets, bolts, washers, and nuts had to be replaced and torqued to manufacturer specifications.

Battelle's electrical subcontractor (Dublin Technical Systems) built to scale a mockup of the 12 ft hood in preparation for the delivery of the test skid. Battelle and Dublin Tech completed programming of the process control system. Dublin Tech completed assembly/wiring of the main CBART electrical panel. The general tradesman contractor (Sauer) installed the deionized water system and air dryer. In addition, Sauer Engineering began installing equipment such as MFCs, humidifiers, and blow-off valves and running copper and stainless steel lines in the HML-8 lab and surrounding areas to support the humidity and tempered water systems.

Battelle made considerable progess on the NRT sampling train. The remaining analytical instruments for the NRT sampling train (GC, mass spectrometer [MS], and Markes 24/7 sampling system) were received. Vendor installation of the GC/MS and associated software was completed. The vendor began installation of the Markes 24/7 system. During initial startup, a short circuit burned out a circuit board on the Markes system. Markes replaced the circuit board as part of its manufacturer's warranty.

5.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA. a. Complete Fabrication of Test System. Battelle finalized the design and layout of the CBART fixture. The finalized design met all safety, ergonomic and operational requirements.

Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. Phase IIIC. b. Construct Sample Train. Battelle began construction of the CBART NRT analytical system. Assembly included procurement of necessary components for system integration, calibration, and evaluation. The sample train incorporated the commercial off-the-shelf (COTS) analytical instrumentation recommended by the peer review panel as well as ancillary equipment and software required for integrating the system into the CBART fixture. Specific equipment included a stream selector, an agent trap, and a GC with a flame ionization detector (FID), flame photometric detector (FPD), and mass selective detector (MSD) capability.

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

5.3 Other Key Events

Battelle modified an existing Hazardous Materials Research Center (HMRC) huddle room into a staging area for the CBART sample train by installing a ventillation system and upgrading the electrical system to 220 V (all Battelle funded).

Team members made a site visit to Mettler Toldeo to discuss possible options for the analytical balance and narrowed the search down to two balances.

Select CBART team members traveled to Texas to present CBART posters at a science conference. All three met with the client at the conference and addressed all test plan comments.

Battelle hosted a CBART stakeholder update via teleconference.

Battelle received the spiking wand and completed the training given by Creare.

6.0: SECOND QUARTER FY10 PROGRESS (JANUARY 1, 2010 – MARCH 31, 2010)

6.1 Summary of Work Performed

Battelle completed construction of the piping portion of the CBART fixture and transferred the fixture from Bruner Corporation to Dublin Technical Systems, a small business subcontractor, for instrument installation and electrical wiring. Battelle also continued programming of the project logic controller, concentrating on safety subroutines and shutdown procedures. Considerable effort was spent on completing assembly and setup of the analytical system and its components.

6.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA. A. Complete Fabrication of Test System. A major milestone was reached as Battelle transitioned the CBART fixture from its piping subcontractor to its electrical subcontractor. The electrical work was the last major off-site construction activity before transferring the fixture into the HMRC laboratory. Electrical work began immediately upon receipt of the fixture by the electrical subcontractor. Battelle also continued programming of the safety procedures and shutdown subroutines. These procedures are integrated as part of the process logic controller and either augment or are in lieu of hardware safety measures.

Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4. Phase IIIB. d. Develop Interface Control Document. Battelle prepared an interface control document that defined the interface between the sampling train and the test fixture.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. Phase IIIC. b. Construct Sample Train. Battelle constructed, tested, and refined as necessary the CBART NRT analytical system. Assembly included procurement of necessary components for system integration, calibration, and evaluation. The sample train incorporated the COTS analytical instrumentation recommended by the peer review panel as well as ancillary equipment and software required to integrate the system with the CBART fixture. Specific equipment included a stream selector, an agent trap, and a GC with FID, FPD, and MSD capability.

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

6.3 Other Key Events

Battelle submitted a proposal for a modification (P0004) to the CBART contract. The modification provided additional funding for integration and provided clarification on some scope increase.

7.0: THIRD QUARTER FY10 PROGRESS (APRIL 1, 2010 – JUNE 30, 2010)

7.1 Summary of Work Performed

Battelle completed all of the off-site assembly activities, specifically the wiring of the CBART skid. While still at the electrical contractor's location, Battelle verified that the process control system was able to communicate with each of the installed components (75% of the total inputs/outputs). Upon completion of the off-site assembly, the fixture and other major components were transferred to and installed in the hoods in the HMRC.
As a parallel effort, Battelle completed the second round of shakedown trials for the analytical sampling train. It was confirmed that the threshold requirement for the lower detection limit could be met. The majority of the work performed during May and early June was completed "at risk" to Battelle and its subcontractors due to the delay in award of modification P0004 to the CBART contract.

7.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA a. Complete Fabrication of the Test System. Battelle completed all of the off-site assembly of the CBART fixture. As part of this effort, Battelle completed the six fixture modifications for this task as identified in the Mod P0004 SOW. These include:

- Modification of the cell interface
- Addition of mechanical assists for the cells
- Increase in incident air cooling capacity
- Expansion of the internal coating
- Addition of additional instruments identified in the safety review
- Improvements to the process control interface

Task 4. Phase IIIA. b. Install CBART Prototype. All three major fixture components were safely transferred to the HMRC, installed in their appropriate hoods and connected into their operational configuration. All wiring was run to the control panel and over 90% of the terminations were completed.

Dublin Technical Systems and Sauer Engineering (another small business service provider) completed approximately 50% of the support instrumentation (outside of the hoods) at the HMRC. These pieces of equipment could not be installed until the fixture was placed into the hoods.

Task 4. Phase IIIA. c. Integrate Subcomponent Items. Battelle formally transferred subcomponent items through Defense

Contract Management Agency (DCMA) that were purchased under the previous CBART contract (W911NF-07-D-0001/DO 0360/TCN 08109) and integrated them into the CBART fixture.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. Phase IIIC. b. Construct Sample Train. Battelle completed modifications to the analytical sample train to allow for analysis of vapor contamination levels during vapor/vapor testing as well as the vapor concentrations in the bypass air. Battelle also incorporated a gravimetrically-based calibration system for the agent droplet dispenser. The system allows for calibration of the agent droplet dispenser before agent spiking as well as allowing for the verification of calibration during the spiking operation.

Battelle also completed two rounds of touchless droplet dispenser shakedown trials. During the first set of trials, Battelle identified a flaw in the dispenser. The dispenser would occasionally deliver a “double droplet” due to switch bounce. Creare confirmed the problem as being switch bounce through testing of the control box and monitoring the traces on an oscilloscope. Creare made a minor modification to the electronics to increase the time constant. The second round of verification trials using water did not produce a single “double droplet” with nearly 2000 droplets dispensed.

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4. Phase IIIE. a. Test Plan Modification. Battelle completed adjudication of comments to the second draft of the CBART Verification Test Plan. An additional draft of the test plan will be required to incorporate the detailed procedures for fixture operations.

Task 4, Phase IIIE. b. System Performance Testing (Non-Agent Challenge). No progress made during this reporting period.

Task 4, Phase IIIE. c. System Performance Testing (Swatch Permeation with Simulant). No progress made during this reporting period.

Task 4, Phase IIIE. d. System Performance Testing (Swatch Permeation). No progress made during this reporting period.

Task 4, Phase IIIE. e. Data Reduction and Delivery. No progress made during this reporting period.

Task 4, Phase IIIE. f. Independent Data Review Support. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

7.3 Other Key Events

Contract modification P0004 awarded on June 10, 2010.

Battelle conducted a detailed tour of the CBART fixture and support equipment for Dr. Charles Bass, Senior S&T Program Manager for Protection and Hazard Mitigation on June 28, 2010.

8.0: FOURTH QUARTER FY10 PROGRESS (JULY 1, 2010 – SEPTEMBER 30, 2010)

8.1 Summary of Work Performed

Battelle completed laboratory installation of the CBART fixture with final input/output (I/O) testing 96% complete. Battelle conducted startup of the tempered water system. The TempestTM unit is operating as advertised.

Battelle installed a particle filter in the supply line of the jacket water loop to ensure residuals from construction don't affect valves and other instruments. In addition, the supply air heat exchanger loop and the blower heat exchanger loop are running. Initial startup of the blower indicated that the blower electrical circuitry is properly connected and controllable with the process logic controller. Shakedown of the blower unit was completed.

Deionized system installation was completed and the system is running.

Battelle completed shakedown evaluation of the analytical sample system and simulant testing on the touchless agent droplet dispenser system. Testing confirms the analytical sampling system will meet threshold requirements for cycle time and will meet or exceed the sensitivity requirement at that sampling duration. Early testing of the agent droplet dispenser indicates that the system accuracy and precision easily meet threshold requirements.

Battelle completed response to comments from the second draft of the verification test plan. The revised test plan, subsystem verification procedures, and response to comments were delivered on September 30, 2010.

8.2 Detailed Work Performed by SOW Element

Task 4, Phase IIIA. a. Complete Fabrication of Test System. No progress made during this reporting period.

Task 4. Phase IIIA. b. Install CBART Prototype. Battelle received the 12 Creare cells and installed 10 of the cells into the fixture. The remaining cells are spares. The mechanical assists that were designed to allow ease in lifting the top portion of the cells were tested by HMRC agent handlers. The staff noted that the mechanical assists greatly improved handling of the relatively heavy hardware.
Battelle completed 95% of the electrical system. Battelle continued the final electrical assembly and I/O verification of the system. There were several issues with the wiring that were identified and corrected by Battelle's electrical subcontractor. Some of the issues were considered "re-work" and correction of the problems was covered under the service supplier's warranty. Approximately 96% of the I/O has been tested and is functioning correctly (includes checking terminations, addressing within the programmable logic controller (PLC), and ensuring functionality of devices).

Approximately 10% of the loop tuning (optimizing the subroutines within the process) has been completed. During tuning, several issues were identified and are being corrected. The issues were mainly related to system leaks, materials failures, and instrument failures.

Battelle conducted startup of the tempered water system in August 2010. The TempestTM unit is operating as advertised. Battelle completed shakedown of the three tempered water circuits. Several small adjustments were required to ensure tight containment of the glycol solutions. All circuits are functional.

Initial startup of the blower indicated that the blower electrical circuitry is properly connected and controllable with the process logic controller. Shakedown of the blower unit was completed. DI system installation was completed and the system is running properly.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. Phase IIIC. b. Construct Sample Train. Battelle completed early testing of the NRT analytical sampling train and determined that as currently configured, the low end sensitivity is 0.25 ng/min or better — 33 times lower than the CBART threshold requirement. In addition to meeting sensitivity requirements, it is critical that the analytical sampling train provide consistent results between the 16 valve ports, 10 of which correspond to the 10 Creare cell sampling positions.

Within each set of five replicates per valve position, the relative standard deviation (RSD) was between 1.6 and 4.1%. The overall RSD between the ports (n = 240) was 6%. In addition to port variability, Battelle also examined carry over between ports. In a similar experiment, the eight even-numbered sample ports were challenged (n = 30 per port) and the odd-numbered ports were not challenged (blanks). The unchallenged ports were analyzed to determine if there was any carry over. The carry over from sample to blank ranged from 0.43 to 0.62% (data not shown). The repeatability on each sample port has been further reduced to ~2% on average and the port-to-port high-to-low percent difference reduced to 15%. These data were collected using both the A and B cold trap on the Markes system, so it provided both a worst case and a realistic analysis scenario. Work continues in this area.

Additional modifications have been made to further reduce the port-to-port difference. The makeup air computer macro that drives the makeup MFC was rewritten to trigger off the initiation and cessation of the Markes sampling. Initial testing of the new macro shows excellent tracking performance now.

Battelle also completed the first round of agent droplet dispenser testing using water and a 70% glycol/30% water solution that has a viscosity similar to VX. Battelle determined that the optimum pressure for delivery was 8 pounds per square inch (psi). At 8 psi, the average RSD was 0.41% between measurements at a particular resistance.

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4, Phase IIIE. a. Test Plan Modification. Battelle delivered a third revision of the CBART plan on September 30, 2010. This submission included individual test plans for several of the subsystems.

Task 4, Phase IIIE. b. System Performance Testing (Non-Agent Challenge). No progress made during this reporting period.

Task 4, Phase IIIE. c. System Performance Testing (Swatch Permeation with Simulant). No progress made during this reporting period.

Task 4, Phase IIIE. d. System Performance Testing (Swatch Permeation). No progress made during this reporting period.

Task 4, Phase IIIE. e. Data Reduction and Delivery. No progress made during this reporting period.

Task 4, Phase IIIE. f. Independent Data Review Support. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

8.3 Other Key Events

Battelle conducted a detailed site visit and update brief of the CBART fixture and support equipment for Dr. Charles Bass, Senior S&T Program Manager for Protection and Hazard Mitigation and several other key stakeholders on August 17, 2010.

Battelle received notification that CBART was selected for a platform presentation during the 2010 CB Defense S&T Conference in November 2010.

Battelle provided program updates to DTRA in preparation for the swatch summit held in September 2010.

9.0: FIRST QUARTER FY11 PROGRESS (OCTOBER 1, 2010 – DECEMBER 31, 2010) and SECOND QUARTER FY11 PROGRESS (JANUARY 1, 2011 – FEBRUARY 15, 2011)

9.1 Summary of Work Performed

Battelle completed the fabrication of the test system. In addition, Battelle nearly completed all of the leak testing and resolving leaks up through the test cells. The subcontractors finished installing all of the support instrumentation (outside of the hoods) at the HMRC. The subcontractors also assisted with the replacement/installation of several faulty pieces of equipment. Battelle installed and configured the data historian and continued with shakedown testing and systemization of the test system, to include starting to verify that the system performs as designed. Considerable progress was made towards the proportional intergral derivative (PID) tuning. The CBART NRT analytical system was developed, moved, replumbed, and electrically installed into the CBART lab. Within-port and between-port variability in main sample train was reduced to ~5%, with carry over measured at about 0.8%. System performance was optimized for cooler temperatures in the lab, which resulted in reducing the run cycle time to 2.88 minutes (500 cycles/24 hours). Battelle completed adjudication of comments to the third draft of the CBART Verification Test Plan, edited the document to address the comments, and added eight appendices which included five additional subsystem test plans.

9.2 Detailed Work Performed by SOW Element

Task 4, Phase IIIA. a. Complete Fabrication of Test System. Battelle completed the fabrication of the test system. In addition, Battelle began working to ensure that the completed fixture will meet all safety and ergonomic requirements for use in the facility and to make necessary design modifications in order to meet the safety and operational requirements. System leak testing and resolving leaks up through the test cells is 95% complete. Bruner Corporation removed, leak tested, and repaired the blower filter housing.

Task 4, Phase IIIA. b. Install CBART Prototype.
Subcontractors: Dublin Technical Systems and Sauer Engineering (both small business service providers) finished all of the support instrumentation (outside of the hoods) at the HMRC. In addition, Dublin Technical Systems completed running all of the wire to the control panel and all terminations were completed. Dublin Technical Systems also completed the addition of DC fuses. Sauer Engineering replaced two three-way valves.

Battelle: Installed and configured the data historian. Cleaned up and organized all interior wiring in the main fixture hood. Ran the Teflon® lines leading to the differential pressure transmitters. Ran Teflon® temporary lines over to the MFCs. Assembled both the operator and analytical work stations. Installed the three M-98 filters. Battelle also completed the following maintenance tasks during this time period:

i. Tempered water system Air HX not responding to SP when trying to lower temperature. Power cycle to controller/pump seems to reset. Replaced temperature controller.
ii. Tempered water system compressor was not able to start properly due to a faulty flow switch. Replaced switch.
iii. Replaced level sensors on system.
iv. Re-piped main fixture drain plumbing to better drain.
v. Replaced two grounded thermocouples with ungrounded on the main fixture.
vi. Replaced insulation that was removed as a result of leak repairs.

Task 4, Phase IIIA. c. Integrate Subcomponent Items: No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing: Battelle continued with shakedown testing and systemization of the test system:

- Temperature, pressure, and velocity control components are all operational.
- Starting to verify that system performs as designed.
- Verified that air flow meets wind speed. System was operated in manual mode to achieve upper wind speed requirement of 3.2 m/s (7 mph) at the following pressure and temperature extremes:
  - Sea level atmospheric pressure and 0°C
  - Sea level atmospheric pressure and 50°C
  - 10,000 ft elevation pressure and 0°C
  - 10,000 ft elevation pressure and 50°C

Notes:

- Temperature difference across test cells met criteria
- Pressure drops across the system are higher than calculated and the blower is close to motor capacity to meet these extremes. There is an issue with the flow conditioning screens in each test cell that Creare is working to resolve.

- Verified that swatch impact air temperature set point and control meet requirements.
- PID tuning is 35% complete (includes both Stage 1 and Stage 2). Only another 10% more work can be carried out until additional modifications on the system are completed.
- Created an human machine interface (HMI) graphics page that shows all of the cell process variables graphically between cells.
- System is measuring pressure and flow, but results vary across the system.
- Ran temperature and pressure characterization tests to assist with redesign of the system elements that do not meet spec.

The test revealed that the heat up time is around 2 hours for the impact air and the carrier air will not reach more than about 35 °C; there is little, if any, heating at the cell probe on the carrier air.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. IIIC. b. Construct Sample Train. The CBART NRT analytical system was moved, plumbed, and electrically installed into the CBART lab. Within-port and between-port variability in the main sample train reduced to ~5%. System performance was optimized for cooler room temperatures, reducing run cycle time to 2.88 minutes (500 cycles/24 hours). Heated transfer line final layout design was completed, and quotes were obtained for purchase; the purchaseis ready to be executed. Ordered and received the zero air generator.

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4. Phase IIIE. a. Test Plan Modification. Battelle completed adjudication of comments to the third draft of the CBART Verification Test Plan. Very few comments have been received and these will be addressed in the final draft of the test plan that will incorporate the detailed step-by-step operating procedures for fixture operation.

Task 4, Phase IIIE. b. System Performance Testing (Non-Agent Challenge). No progress made during this reporting period.

Task 4, Phase IIIE. c. System Performance Testing (Swatch Permeation with Simulant). No progress made during this reporting period.

Task 4, Phase IIIE. d. System Performance Testing (Swatch Permeation). No progress made during this reporting period.

Task 4, Phase IIIE. e. Data Reduction and Delivery. No progress made during this reporting period.

Task 4, Phase IIIE. f. Independent Data Review Support. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

9.3 Other Key Events

Battelle and team members held an internal independent design review. Conclusions from this design review included:

i. Highly complex, first of kind system
ii. System looks good on paper and in hardware
iii. Insufficient funds to complete project

iv. Schedule was optimistic

Recommendations of the design review included:

i. Add part-time system engineer
ii. Add part-time mechanical engineer
iii. Bring operator into the system now rather than later
iv. Hire temporary control system programmer and use split shifts to accelerate PID tuning schedule
v. Use of detailed punch list to monitor progress and track costs
vi. Management review at weekly meetings
vii. Update punch list with % complete
viii. Compare labor and materials estimates to actuals
ix. Monthly earned value management reporting to DTRA
x. More frequent dialogue with DTRA on technical issues and potential impact on performance

Battelle held a CBART status meeting with the entire Battelle team and Dr. Charles Bass and William Buechter of DTRA. The objective of this meeting was to update DTRA on all work to date, all future work, discuss any significant issues/risks, and determine how much funds would be required to get to the TRR and to complete all the testing.

9.4 Path Forward

Complete the remaining 25% of fixture troubleshooting. Install parts, verify the modifications are effective, and retune loops affected by modifications. Begin the NRT analytical system carryover evaluation and resolution work.

Technology Transfer

FINAL REPORT

Chemical/Biological Agent Resistance Test (CBART) Fixture Verification and Analytical Monitoring System Development

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Project Number: CB07PRO501
Agreement Number: W911NF-09-C-0053
Capability Area: Protection

DISCLAIMER

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The use of trade names in this report does not constitute endorsement of any commercial product.

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ABBREVISTIONS AND ACRONYMS

ARO	Army Research Office
CAD	computer aided design
CBART	Chemical Biological Agent Resistance Test
COTS	commercial off-the-shelf
DCMA	Defense Contract Management Agency
DI	deionized
DoD	Department of Defense
DTRA	Defense Threat Reduction Agency
FID	flame ionization detector
FPD	flame photometric detector
GC	gas chromatograph
HD	Distilled Sulfur Mustard, a vesicant chemical warfare agent with the chemical formula name of 1,5-Dichloro-3-thiapentane
HMI	human machine interface
HMRC	Hazards Materials Research Center
I/O	Input/Output
JSTO	Joint Science and Technology Office
MFC	mass flow controller
MS	mass spectrometer
MSD	mass selective detector
NRT	near real-time
PID	proportional intergral derivative
PLC	programmable logic controller
psi	pounds per square inch
RSD	relative standard deviation
SOW	Statement of Work
SRM	standard reference material
TRR	test readiness review
VX	A chemical warfare nerve agent with the chemical formula name of Ethyl {[2-[di(propan-2-yl)amino]ethylsulfanyl} methylphosphonate

1.0: PROJECT AND REPORT OVERVIEW

1.1 Objective

The objective of this project was to complete Chemical Biological Agent Resistance Test (CBART) fixture assembly, analytical monitoring system development, and verification testing. The specific objectives that were met, partially met, and not met include:

- Completed the construction of the prototype CBART system
- Completed identifying the components and design of a near real-time (NRT) sampling train
- Completed the construction of the NRT sampling train
- Partially completed shakedown testing of the prototype CBART system
- Partially completed verifying that the CBART fixture meets user safety requirements
- Partially completed integrating the NRT sampling train with the CBART fixture
- Did not complete the verification testing of the NRT sampling train
- Did not complete the system verification test readiness review (TRR)
- Did not complete a series of CBART fixture performance trials to verify the ability of the prototype test fixture to meet system test requirements
- Did not complete documenting the performance of standard reference materials (SRMs) under CBART conditions.

Note: All of the above objectives that have been partially met or not met at this time will be completed through a follow-on contract. Objectives were either partially completed or not completed because the construction and shakedown stages took longer to complete and took more funds than originally estimated. In addition, a number of unplanned moficifcations to the fixture were carried out.

1.2 Approach

Battelle used a systems integration approach to manage the CBART development efforts. At various stages of the project, Battelle coordinated directly with the stakeholders to ensure they were up to date and that their concerns were considered and addressed. Figure 1 shows the systems engineering Vee diagram for CBART along with the stakeholder contact points that occurred to date.

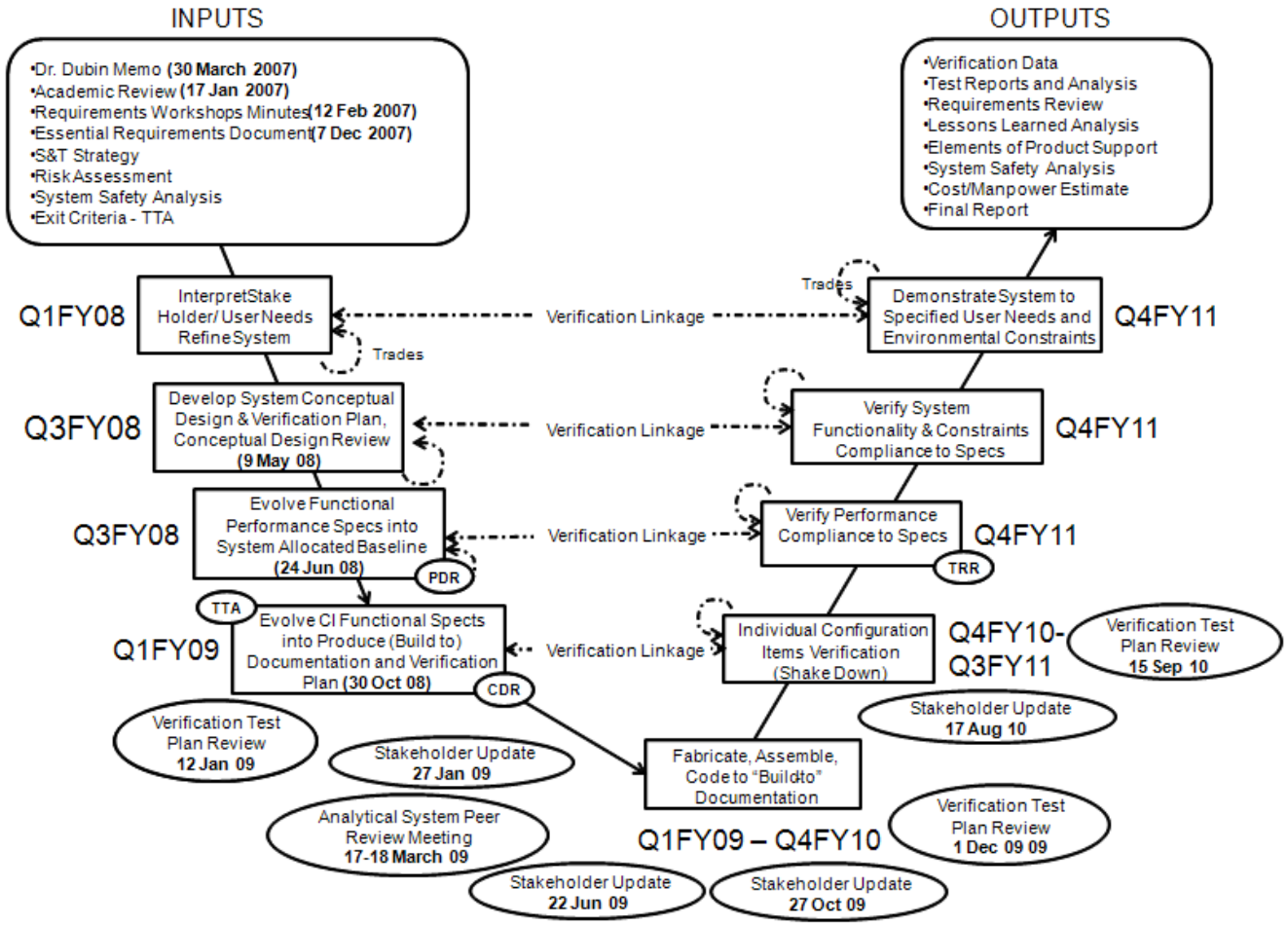


Figure 1. System Integration Vee Diagram for the CBART System Development Program

1.3 Performance

Over the course of the two-year project, Battelle concentrated on the following Statement of Work (SOW) Task 4 phases:

- *Task 4, Phase IIIA. a. Complete Fabrication of Test System.*
- *Task 4, Phase IIIA. b. Install CBART Prototype.*
- *Task 4, Phase IIIA. c. Integrate Subcomponent Items.*
- *Task 4, Phase IIIA. d. Conduct Shake Down Testing.*
- *Task 4, Phase IIIB. a. Conduct System Analysis.*
- *Task 4, Phase IIIB. b. Convene a Peer Review.*
- *Task 4, Phase IIIB. c. Design Sample Train.*
- *Task 4, Phase IIIB. d. Develop Interface Control Document.*
- *Task 4, Phase IIIC. a. Development Plan.*
- *Task 4, Phase IIIC. b. Construct Sample Train.*
- *Task 4, Phase IIIE. a. Test Plan Modification.*

2.0: SECOND QUARTER FY09 PROGRESS (FEBRUARY 11, 2009 – MARCH 31, 2009)

2.1 Summary of Work Performed

Battelle implemented a system engineering process that was used to facilitate a peer review and gather necessary information to design the CBART sample train. The peer review was held at the Thayer Hotel in West Point, New York.

Battelle held an internal CBART system safety review. This was jointly funded with the previous CBART contract (Contract No.DAAD19-02-D-0001, DO No. 0360, TCN 08-109) and delivered to Defense Threat Reduction Agency (DTRA) as part of the contract closeout. The safety review followed the Department of Defense (DoD) Standard Practice for System Safety (MIL-STD-882D) recommendations for probability, severity, and risk assessment for each scenario. A final report was generated as a result of the system safety review. The results of this report were then used to modify the design and layout of the CBART fixture. Figure 2 is a depiction of the fixture design/layout through the end of this quarter.

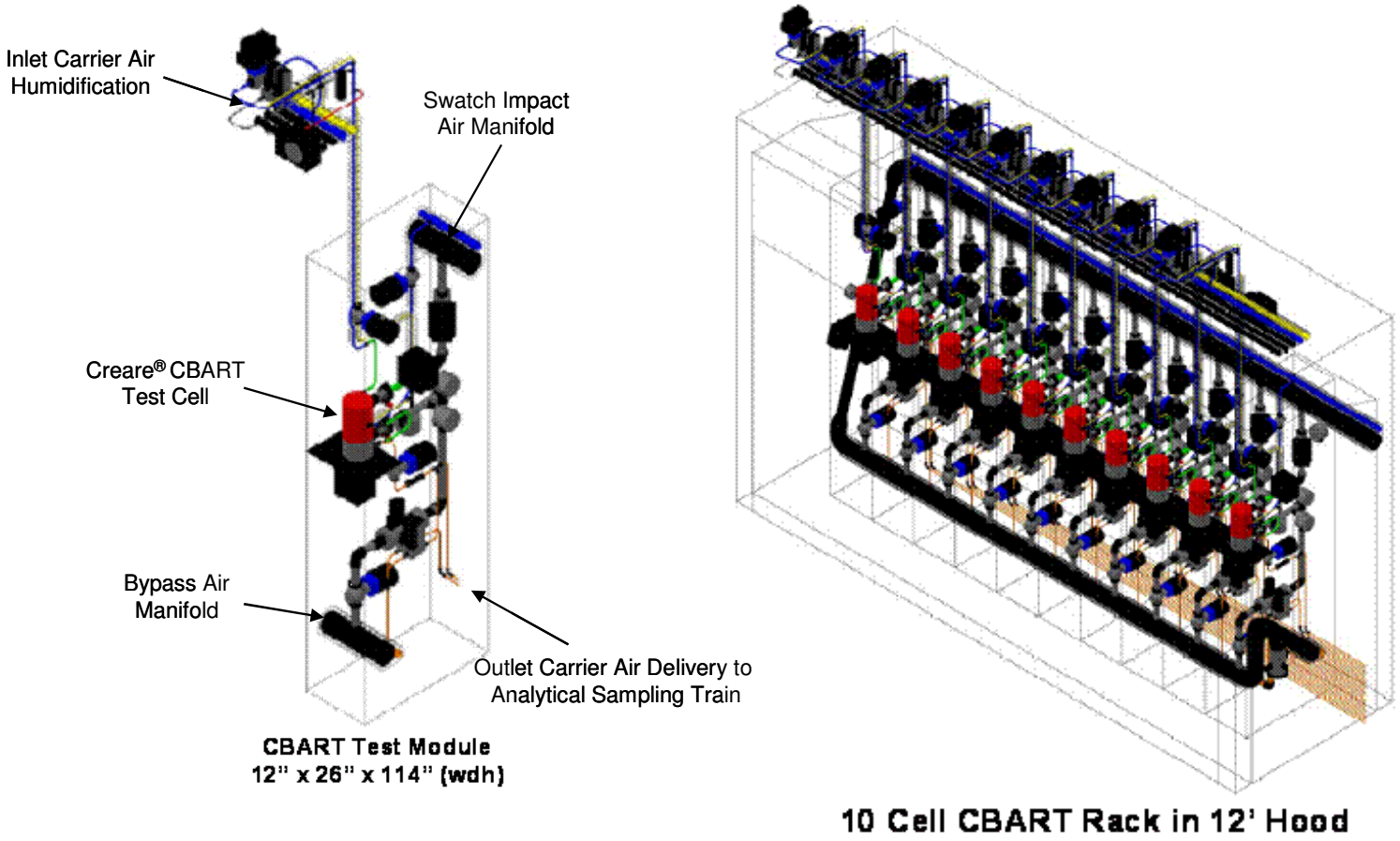


Figure 2. Inital CBART Fixture Design/Layout (as of March 31, 2009)

2.2 Detailed Work Performed by SOW Element

Task 4, Phase IIIA. a. Complete Fabrication of Test System. No progress made during this reporting period.

Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4. Phase IIIB. a. Conduct a Systems Analysis. Battelle implemented a system engineering process to review requirements, identify technology gaps/limitations and develop design concepts based on existing methods to meet the requirements for a CBART sampling train/analytical process.

Task 4. Phase IIIB. b. Convene a Peer Review. Battelle worked directly with DTRA Joint Science and Technology Office (JSTO) to identify participants and convene an independent peer review.

1) Attendees consisted of analytical chemistry and permeation testing subject matter experts from academia, government, and industry.
2) Attendees had expertise in chemical agent analysis, agent properties, sample collection, and existing sampling hardware and methods.
3) Battelle developed a representative scenario to estimate potential below swatch agent concentration for determining analytical sensitivity requirements. The scenario was based on typical collective protection equipment and protection scenarios versus nerve agent VX (VX). Peer review panel members used the requirements developed from the model for the basis of their recommendations.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a-d. Prototype Analytical System Construction and Verification. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

2.3 Other Key Events

Battelle and subcontractors removed all existing electrical, mechanical, ventillation, and hoods from an existing lab to make room for the CBART fixture (funded by Battelle).

Battelle began procuring long lead items such as mass flow controllers (MFCs) and air flow valves.

3.0: THIRD QUARTER FY09 PROGRESS (APRIL 1, 2009 – JUNE 30, 2009)

3.1 Summary of Work Performed

All three CBART hoods (one 6 ft to house the blower, one 8 ft to house the analytical system, and one 12 ft to house the CBART fixture/cells) were delivered and installed into the modified Battelle laboratory (funded by Battelle).

Battelle dispersed the CBART draft peer review sample train report, received and responded to comments, finalized, and sent it back to the client.

The Battelle Program Plan (internal document) was written and finalized. The Battelle test team began addressing the verification test plan comments from the first version. These comments were incorporated into the second version. Battelle began using the final peer review panel report to detail the design of the sample train. In addition, Battelle began working on preliminary computer aided design (CAD) drawings of the sample train and the sample train development plan.

Due to the growing complexity of the fixture and to make sure the system was "user friendly", three rudimentary test cell mock-ups were built to allow the test team to refine the design of the fixture (Figure 3).

The Army Research Office (ARO) accepted and fully funded the contract. Work prior to this quarter was funded via pre-award funds.

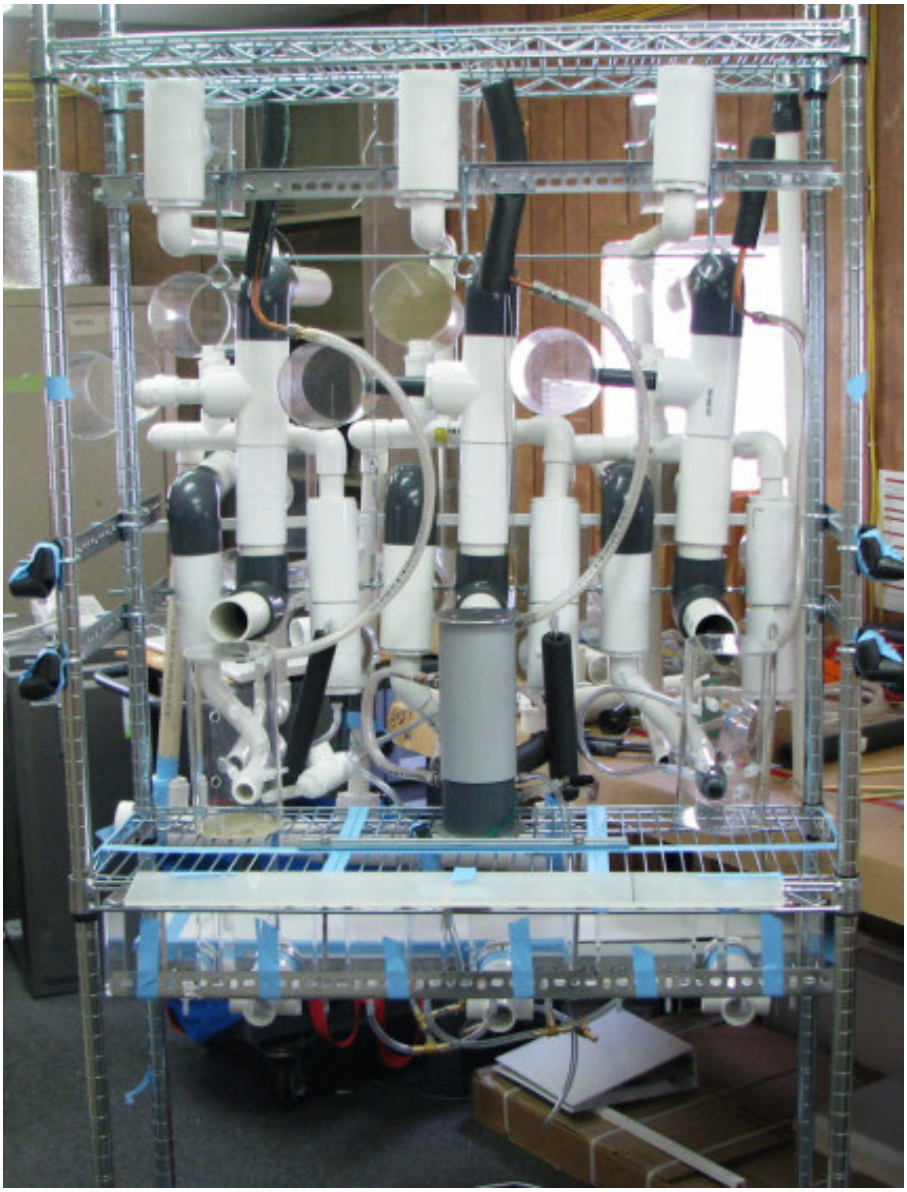


Figure 3. CBART Rudimentary Test Cell Mock-Ups

Battelle prepared for and hosted a CBART stakeholder update. The update was held via teleconference and focused on the contract status, schedule, current progress, risks to the project, and the projected path forward. The meeting was also used to discuss the status of the sample train design.

3.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA. a. Complete Fabrication of Test System. Battelle continued with design and layout of the CBART fixture and incorporating results of the safety review report into the design of the fixture. Figure 4 is a depiction of the fixture design/layout (without wiring and insulation) through the end of this quarter.

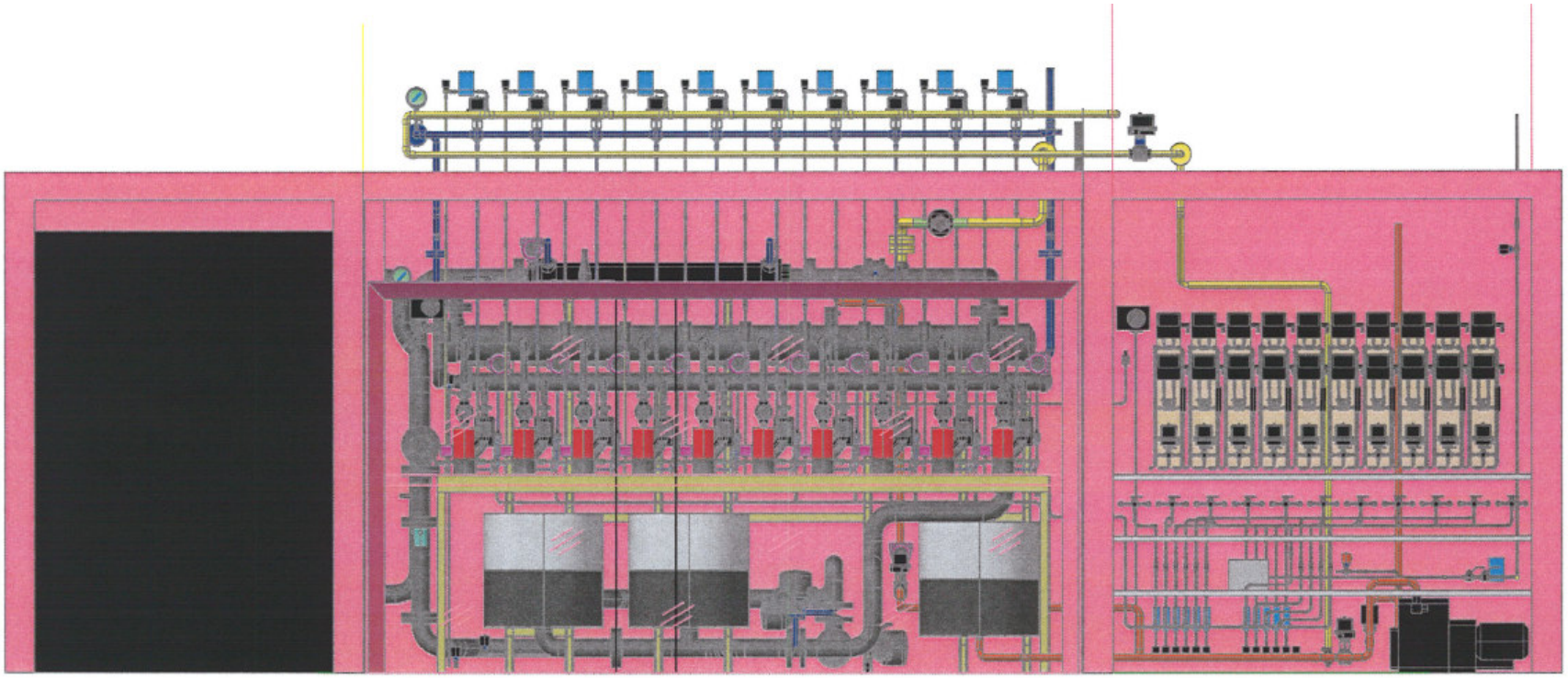


Figure 4. Preliminary CBART Fixture Design/Layout (as of June 30, 2009)

Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4. Phase IIIB. b. Convene a Peer Review. Battelle worked directly with DTRA JSTO to identify participants and convene an independent peer review. The peer review panel identified existing methodology and equipment suitable for use in NRT sampling within the CBART breadboard. Panel members identified advantages and disadvantages of the hardware and processes recommended. The panel compiled the information into an overall recommendation for implementation into CBART that included suggestions for additional data gathering and a recommended path forward.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a-d. Prototype Analytical System Construction and Verification. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

3.3 Other Key Events

Battelle delivered a spreadsheet to ARO and DTRA outlining the cost issues within the project. This spreadsheet covered cost impact for current scope, potential scope growth that resulted from the stakeholder review of the verification test plan (first version), and potential scope growth associated with the peer-panel recommended sample train.

4.0: FOURTH QUARTER FY09 PROGRESS (JULY 1, 2009 – SEPTEMBER 30, 2009)

4.1 Summary of Work Performed

Battelle finalized the CBART fixture design and layout in AutoCAD. Figure 5 shows the current CAD representation of the CBART fixture (without wiring and insulation). The design of the dionized (DI) water system that will feed the CBART fixture was finalized as well as the electrical process/control design of the CBART fixture. Battelle's piping subcontractor, Bruner Corporation, began and completed fabrication of the CBART fixture (Figure 6). Once complete, the fixture was dissasembled, cut up into pieces, and shipped to Silco-Tek for coating. Due to the weight of all of the equipment and piping associated with the main fixture, an enhanced support structure was designed and added to the fixture.

Battelle prepared and submitted a proposal to capture add-on costs of ~$875,000. Funding was received. Part of this effort included a modification of the current contract to re-program funds in the amount of $139,217 in labor funding to construct the analytical sampling train subcomponent of the CBART fixture.

Battelle finalized the design of the analytical hood configuration with sample train (Figure 7). In addition, Battelle completed a preliminary CAD of the CBART sample train and a sample train development plan. Battelle ordered all analytical equipment associated with the sample train, including custom software to control purge air MFC and a custom gas chromatograph (GC) oven and began to receive the first pieces of the sample train (MSD/DS, 7890A Series GC, and Markes System).

Battelle's electrical subcontractor, Dublin Technical Systems, began design and assembly/wiring of the main CBART electical panel. Battelle received additional significant pieces of equipment to include the blower, vacuum pump, and the first Creare cell. In addition, all remaining long lead items were received including the Keystone valves.

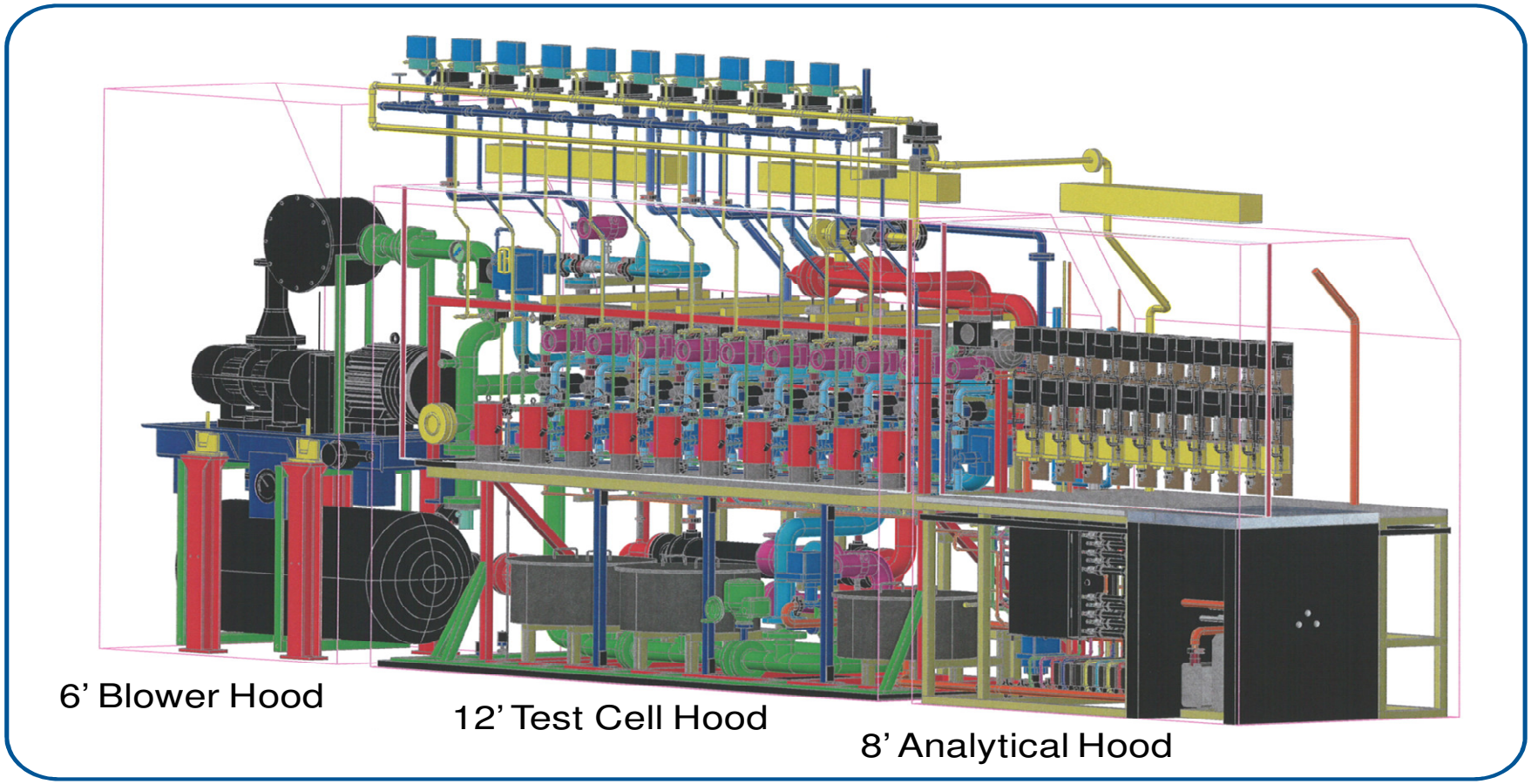


Figure 5. Final CBART Fixture Design/Layout (as of September 30, 2009)

Figure 6. Start of CBART Fixture Fabrication (as of September 30, 2009)

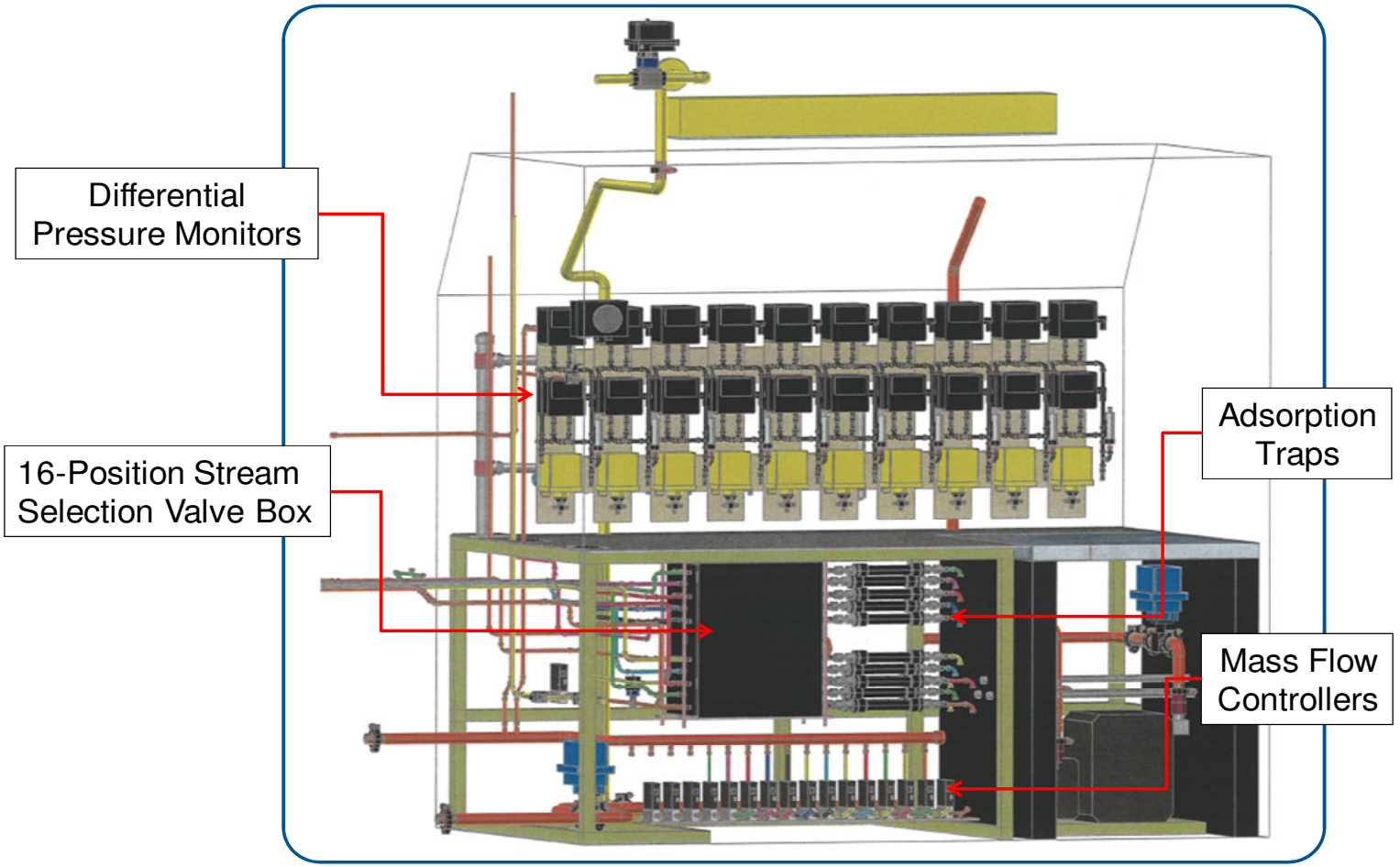


Figure 7. Final CBART Analytical Hood Configuration with Sample Train (as of September 30, 2009)

4.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA. a. Complete Fabrication of Test System. Battelle finalized the design and layout of the CBART fixture. The finalized design met all safety, ergonomic and operational requirements.

Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4. Phase IIIB. c. Design Sample Train. Using the results of the peer review and supporting studies, Battelle completed a preliminary CAD design of the CBART sample train. Note, Battelle continued to update the CAD package throughout the year.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4. Phase IIIC. a. Development Plan. Battelle prepared a development plan which included a summary of the planned activities in building the automated NRT analytical system. The plan included an outline of the verification procedure for testing the system following the build, and the selection and rationale for a model challenge chemical to be used for development and verification.

Task 4, Phase IIIC. b. Construct Sample Train. No progress made during this reporting period.

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

4.3 Other Key Events

Battelle and its subcontractors completed all laboratory modifications, to include hood air flow balance (funded by Battelle).

Select members of the Battelle test team traveled to Creare to witness a demonstration of the CBART spiking wand.

5.0: FIRST QUARTER FY10 PROGRESS (OCTOBER 1, 2009 – DECEMBER 31, 2009)

5.1 Summary of Work Performed

Battelle finalized completion of addressing verification test plan comments and issued a second draft to the client. Battelle finalized the CBART support structure design and the mechanical subcontractor (Bruner Corporation) completed the build. Bruner received coated pieces from Silco-Tek and began the reassembly process (80% complete). During the reassembly process, it was determined that all piping coated by Silco-Tek had not been properly cleaned before being shipped. The entire skid was completely dissembled, all piping was cleaned by hand, and then the entire skid was reassembled. In order to reassemble the skid, all of the gaskets, bolts, washers, and nuts had to be replaced and torqued to manufacturer specifications.

Battelle's electrical subcontractor (Dublin Technical Systems) built to scale a mockup of the 12 ft hood in preparation for the delivery of the test skid. Battelle and Dublin Tech completed programming of the process control system. Dublin Tech completed assembly/wiring of the main CBART electrical panel. The general tradesman contractor (Sauer) installed the deionized water system and air dryer. In addition, Sauer Engineering began installing equipment such as MFCs, humidifiers, and blow-off valves and running copper and stainless steel lines in the HML-8 lab and surrounding areas to support the humidity and tempered water systems.

Battelle made considerable progess on the NRT sampling train. The remaining analytical instruments for the NRT sampling train (GC, mass spectrometer [MS], and Markes 24/7 sampling system) were received. Vendor installation of the GC/MS and associated software was completed. The vendor began installation of the Markes 24/7 system. During initial startup, a short circuit burned out a circuit board on the Markes system. Markes replaced the circuit board as part of its manufacturer's warranty.

5.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA. a. Complete Fabrication of Test System. Battelle finalized the design and layout of the CBART fixture. The finalized design met all safety, ergonomic and operational requirements.

Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. Phase IIIC. b. Construct Sample Train. Battelle began construction of the CBART NRT analytical system. Assembly included procurement of necessary components for system integration, calibration, and evaluation. The sample train incorporated the commercial off-the-shelf (COTS) analytical instrumentation recommended by the peer review panel as well as ancillary equipment and software required for integrating the system into the CBART fixture. Specific equipment included a stream selector, an agent trap, and a GC with a flame ionization detector (FID), flame photometric detector (FPD), and mass selective detector (MSD) capability.

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

5.3 Other Key Events

Battelle modified an existing Hazardous Materials Research Center (HMRC) huddle room into a staging area for the CBART sample train by installing a ventillation system and upgrading the electrical system to 220 V (all Battelle funded).

Team members made a site visit to Mettler Toldeo to discuss possible options for the analytical balance and narrowed the search down to two balances.

Select CBART team members traveled to Texas to present CBART posters at a science conference. All three met with the client at the conference and addressed all test plan comments.

Battelle hosted a CBART stakeholder update via teleconference.

Battelle received the spiking wand and completed the training given by Creare.

6.0: SECOND QUARTER FY10 PROGRESS (JANUARY 1, 2010 – MARCH 31, 2010)

6.1 Summary of Work Performed

Battelle completed construction of the piping portion of the CBART fixture and transferred the fixture from Bruner Corporation to Dublin Technical Systems, a small business subcontractor, for instrument installation and electrical wiring. Battelle also continued programming of the project logic controller, concentrating on safety subroutines and shutdown procedures. Considerable effort was spent on completing assembly and setup of the analytical system and its components.

6.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA. A. Complete Fabrication of Test System. A major milestone was reached as Battelle transitioned the CBART fixture from its piping subcontractor to its electrical subcontractor. The electrical work was the last major off-site construction activity before transferring the fixture into the HMRC laboratory. Electrical work began immediately upon receipt of the fixture by the electrical subcontractor. Battelle also continued programming of the safety procedures and shutdown subroutines. These procedures are integrated as part of the process logic controller and either augment or are in lieu of hardware safety measures.

Task 4, Phase IIIA. b. Install CBART Prototype. No progress made during this reporting period.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4. Phase IIIB. d. Develop Interface Control Document. Battelle prepared an interface control document that defined the interface between the sampling train and the test fixture. A sketch of the sample train interface is shown in Figure 8.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. Phase IIIC. b. Construct Sample Train. Battelle constructed, tested, and refined as necessary the CBART NRT analytical system. Assembly included procurement of necessary components for system integration, calibration, and evaluation. The sample train incorporated the COTS analytical instrumentation recommended by the peer review panel as well as ancillary equipment and software required to integrate the system with the CBART fixture. Specific equipment included a stream selector, an agent trap, and a GC with FID, FPD, and MSD capability.

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4, Phase IIIE. a-f. CBART Prototype System Testing. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

6.3 Other Key Events

Battelle submitted a proposal for a modification (P0004) to the CBART contract. The modification provided additional funding for integration and provided clarification on some scope increase.

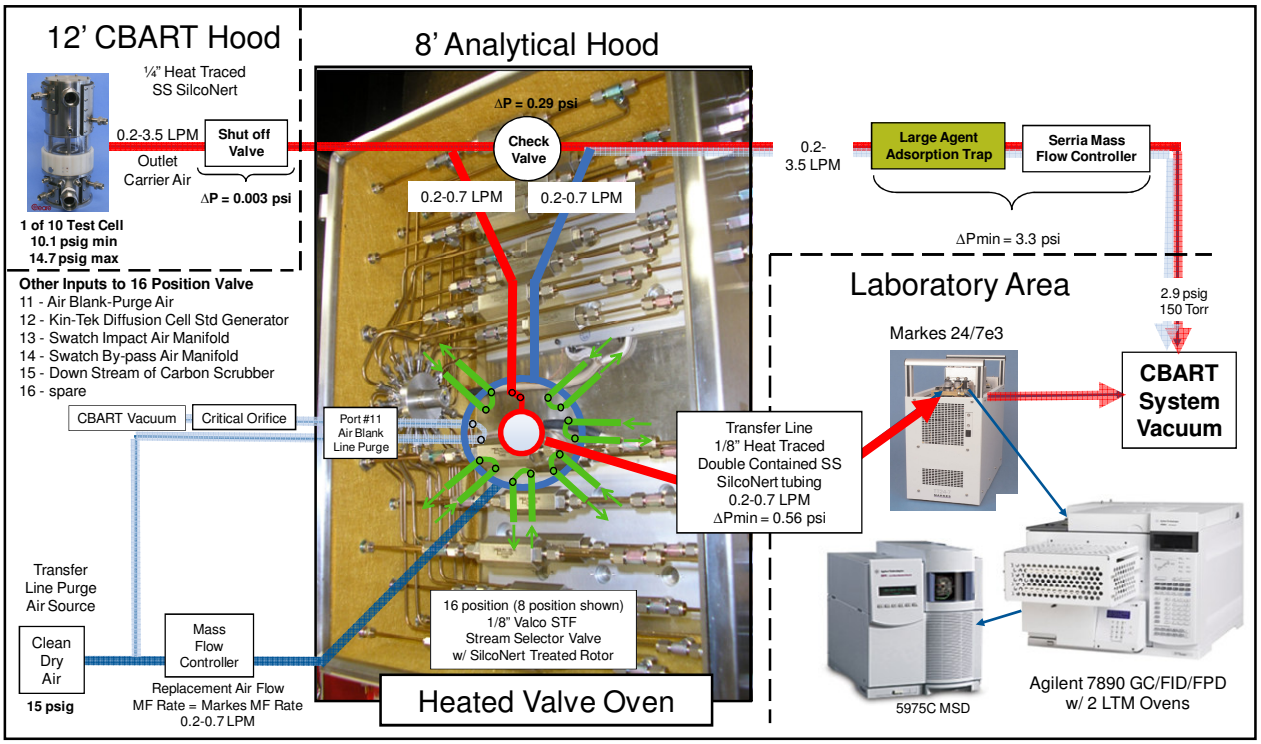


Figure 8. Schematic of the Sample Train Interface

7.0: THIRD QUARTER FY10 PROGRESS (APRIL 1, 2010 – JUNE 30, 2010)

7.1 Summary of Work Performed

Battelle completed all of the off-site assembly activities, specifically the wiring of the CBART skid. While still at the electrical contractor's location, Battelle verified that the process control system was able to communicate with each of the installed components (75% of the total inputs/outputs). Upon completion of the off-site assembly, the fixture and other major components were transferred to and installed in the hoods in the HMRC. Figure 9 shows the crane-assisted transfer of the CBART fixture into the HMRC.

As a parallel effort, Battelle completed the second round of shakedown trials for the analytical sampling train. It was confirmed that the threshold requirement for the lower detection limit could be met. The majority of the work performed during May and early June was completed "at risk" to Battelle and its subcontractors due to the delay in award of modification P0004 to the CBART contract.

7.2 Detailed Work Performed by SOW Element

Task 4. Phase IIIA a. Complete Fabrication of the Test System. Battelle completed all of the off-site assembly of the CBART fixture. As part of this effort, Battelle completed the six fixture modifications for this task as identified in the Mod P0004 SOW. These include:

- Modification of the cell interface
- Addition of mechanical assists for the cells
- Increase in incident air cooling capacity
- Expansion of the internal coating
- Addition of additional instruments identified in the safety review
- Improvements to the process control interface (see Figure 10)

Figure 9. CBART Fixture Transfer into the HMRC

Task 4. Phase IIIA. b. Install CBART Prototype. All three major fixture components were safely transferred to the HMRC, installed in their appropriate hoods (see Figures 11 through 13) and connected into their operational configuration. All wiring was run to the control panel and over 90% of the terminations were completed (see Figure 14).

Dublin Technical Systems and Sauer Engineering (another small business service provider) completed approximately 50% of the support instrumentation (outside of the hoods) at the HMRC. These pieces of equipment could not be installed until the fixture was placed into the hoods.

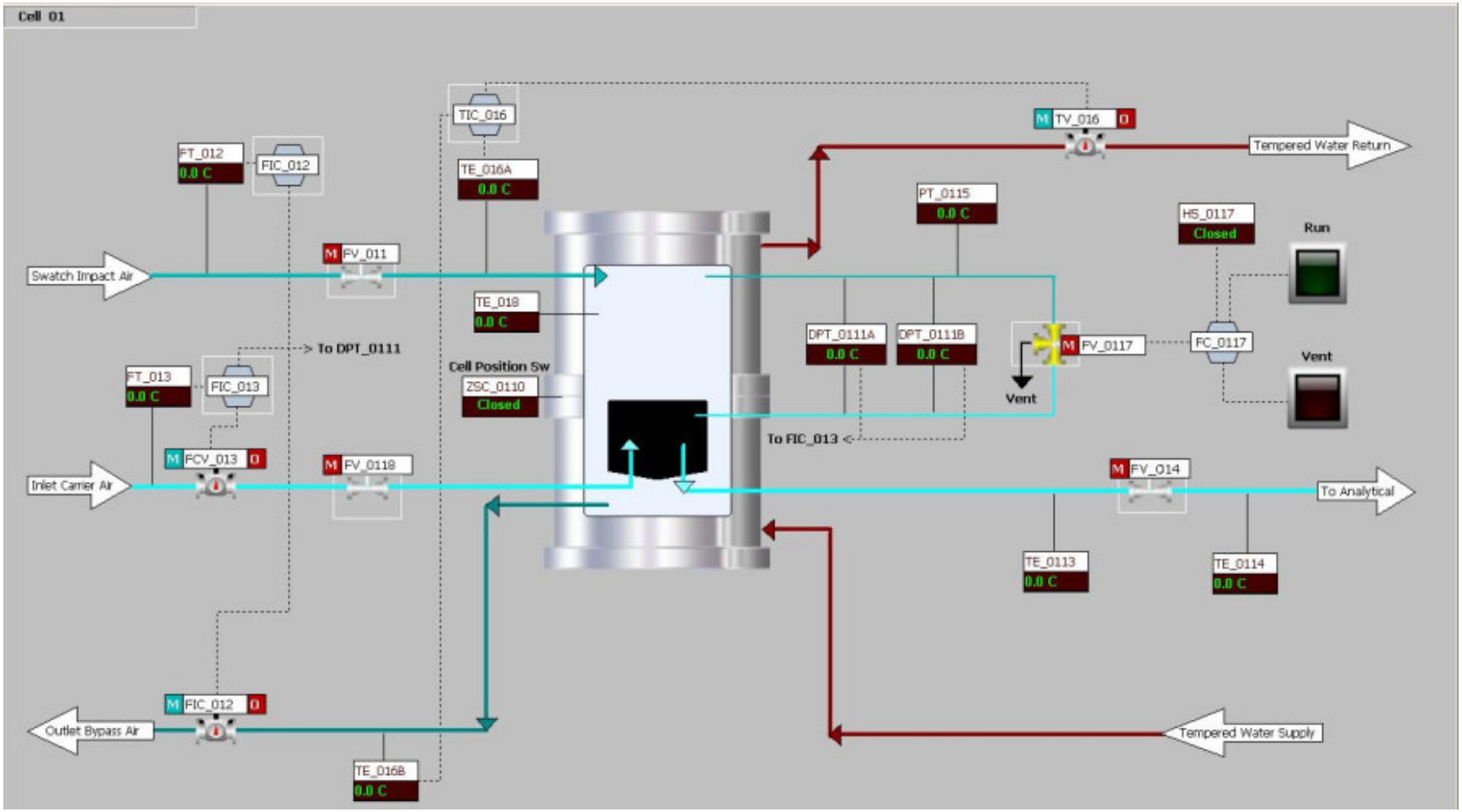


Figure 10. Screenshot Example of the Cell Process Control Interface

Figure 11. CBART Main Test Fixture Installed in the 12-ft Hood

Figure 12. CBART Blower Assembly Installed in the 6-ft Hood

Figure 13. CBART Analytical Work Station Installed in the 8-ft Hood

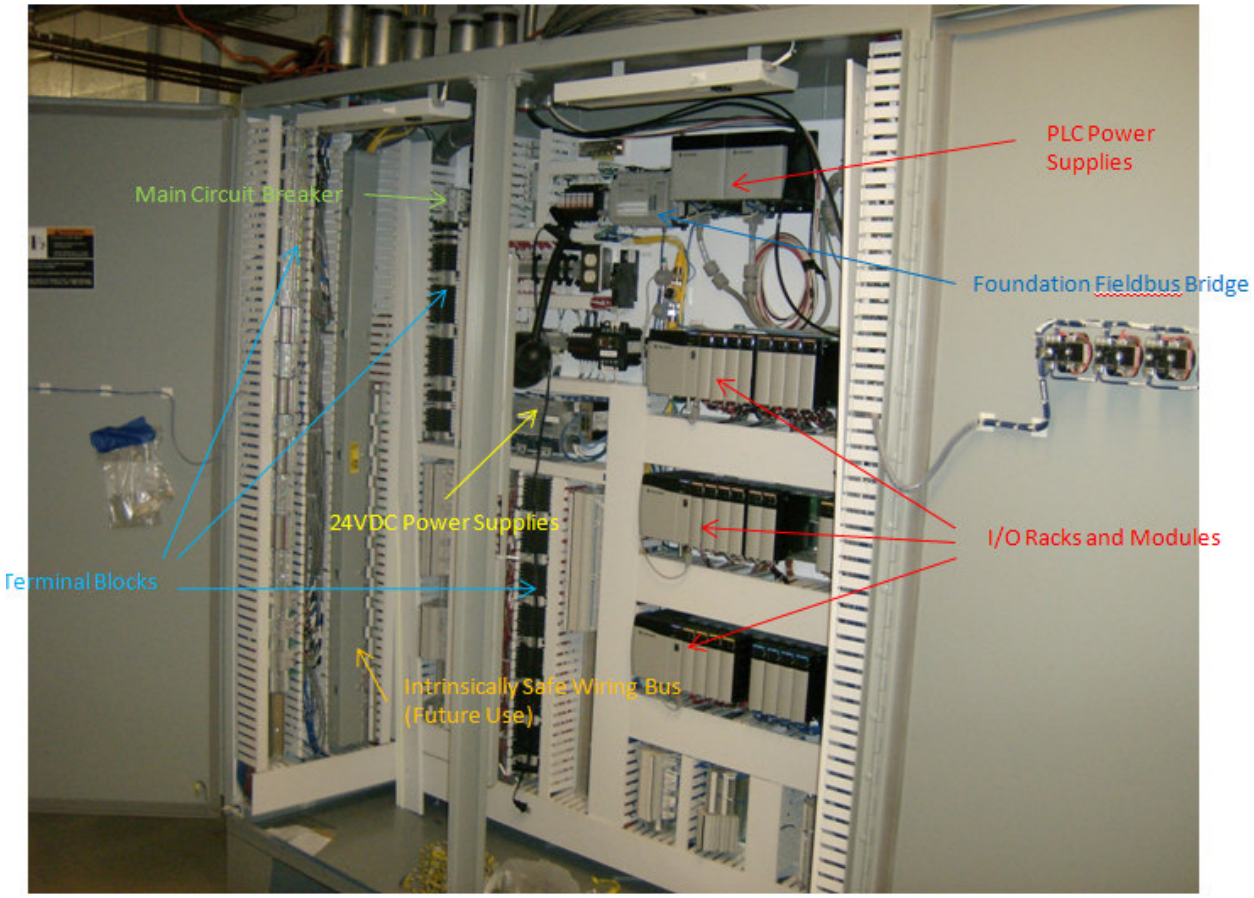


Figure 14. CBART Process Control/Data Acquisition Panel

Task 4. Phase IIIA. c. Integrate Subcomponent Items. Battelle formally transferred subcomponent items through Defense Contract Management Agency (DCMA) that were purchased under the previous CBART contract (W911NF-07-D-0001/DO 0360/TCN 08109) and integrated them into the CBART fixture.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. Phase IIIC. b. Construct Sample Train. Battelle completed modifications to the analytical sample train to allow for analysis of vapor contamination levels during vapor/vapor testing as well as the vapor concentrations in the bypass air. Battelle also incorporated a gravimetrically-based calibration system for the agent droplet dispenser. The system allows for calibration of the agent droplet dispenser before agent spiking as well as allowing for the verification of calibration during the spiking operation.

Battelle also completed two rounds of touchless droplet dispenser shakedown trials (see Figure 15). During the first set of trials, Battelle identified a flaw in the dispenser. The dispenser would occasionally deliver a “double droplet” due to switch bounce. Creare confirmed the problem as being switch bounce through testing of the control box and monitoring the traces on an oscilloscope. Creare made a minor modification to the electronics to increase the time constant. The second round of verification trials using water did not produce a single “double droplet” with nearly 2000 droplets dispensed.

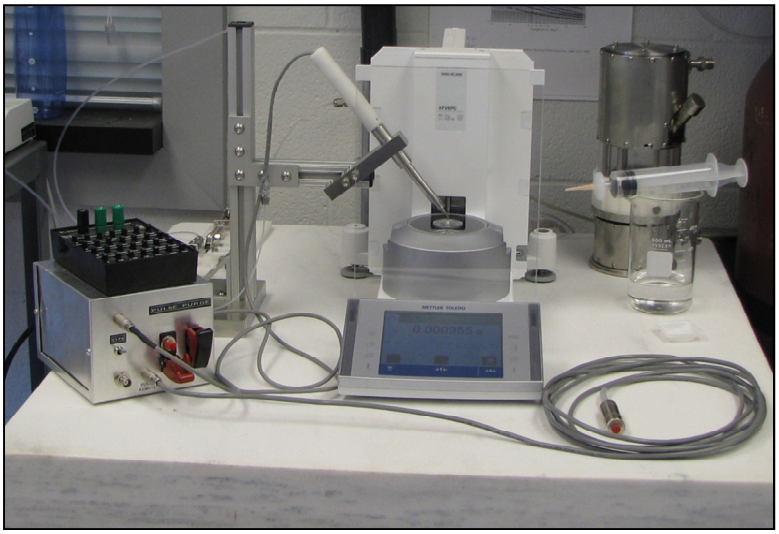


Figure 15. CBART Touchless Dispenser Mounted on an Analytical Balance

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4. Phase IIIE. a. Test Plan Modification. Battelle completed adjudication of comments to the second draft of the CBART Verification Test Plan. An additional draft of the test plan will be required to incorporate the detailed procedures for fixture operations.

Task 4, Phase IIIE. b. System Performance Testing (Non-Agent Challenge). No progress made during this reporting period.

Task 4, Phase IIIE. c. System Performance Testing (Swatch Permeation with Simulant). No progress made during this reporting period.

Task 4, Phase IIIE. d. System Performance Testing (Swatch Permeation). No progress made during this reporting period.

Task 4, Phase IIIE. e. Data Reduction and Delivery. No progress made during this reporting period.

Task 4, Phase IIIE. f. Independent Data Review Support. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

7.3 Other Key Events

Contract modification P0004 awarded on June 10, 2010.

Battelle conducted a detailed tour of the CBART fixture and support equipment for Dr. Charles Bass, Senior S&T Program Manager for Protection and Hazard Mitigation on June 28, 2010.

8.0: FOURTH QUARTER FY10 PROGRESS (JULY 1, 2010 – SEPTEMBER 30, 2010)

8.1 Summary of Work Performed

Battelle completed laboratory installation of the CBART fixture with final input/output (I/O) testing 96% complete. Battelle conducted startup of the tempered water system. The Tempest™ unit is operating as advertised (see Figure 16).

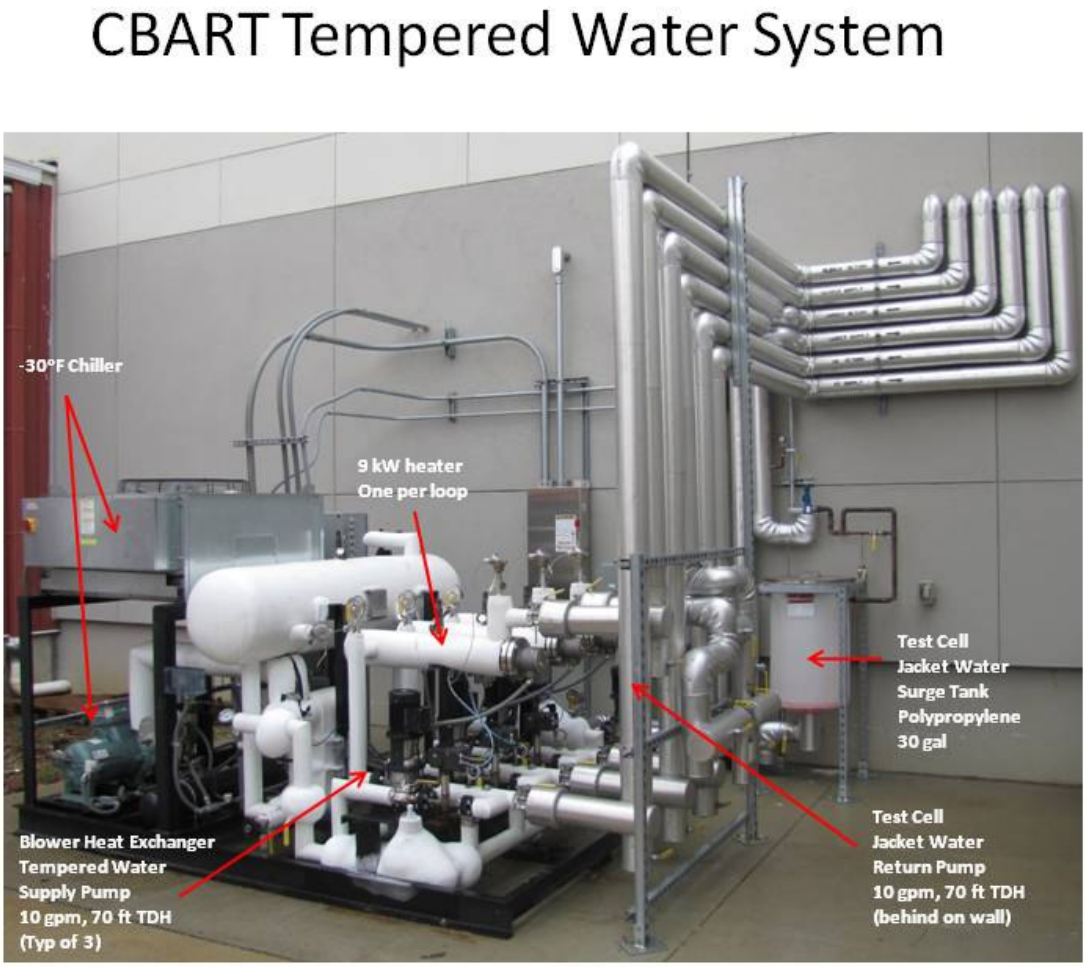


Figure 16. CBART Tempered Water System.

Battelle installed a particle filter in the supply line of the jacket water loop to ensure residuals from construction don't affect valves and other instruments. In addition, the supply air heat exchanger loop and the blower heat exchanger loop are running. Initial startup of the blower indicated that the blower electrical circuitry is properly connected and controllable with the process logic controller. Shakedown of the blower unit was completed.

Deionized system installation was completed and the system is running (see Figure 17).

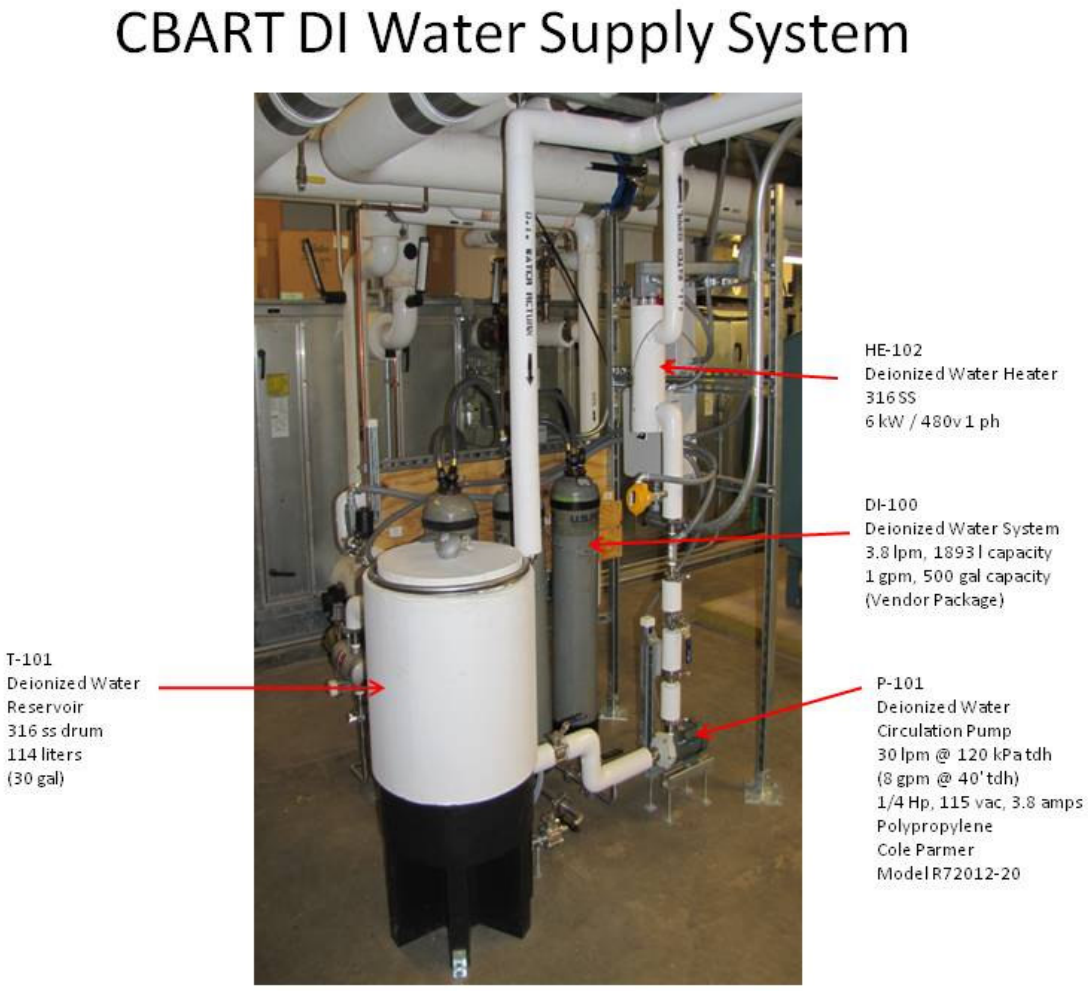


Figure 17. CBART DI Water Supply System

Battelle completed shakedown evaluation of the analytical sample system and simulant testing on the touchless agent droplet dispenser system. Testing confirms the analytical sampling system will meet threshold requirements for cycle time and will meet or exceed the sensitivity requirement at that sampling duration. Early testing of the agent droplet dispenser indicates that the system accuracy and precision easily meet threshold requirements.

Battelle completed response to comments from the second draft of the verification test plan. The revised test plan, subsystem verification procedures, and response to comments were delivered on September 30, 2010.

8.2 Detailed Work Performed by SOW Element

Task 4, Phase IIIA. a. Complete Fabrication of Test System. No progress made during this reporting period.

Task 4. Phase IIIA. b. Install CBART Prototype. Battelle received the 12 Creare cells and installed 10 of the cells into the fixture. The remaining cells are spares. The mechanical assists that were designed to allow ease in lifting the top portion of the cells were tested by HMRC agent handlers. The staff noted that the mechanical assists greatly improved handling of the relatively heavy hardware. Figure 18 shows a Creare cell mounted into the CBART fixture.

Battelle completed 95% of the electrical system. Battelle continued the final electrical assembly and I/O verification of the system. There were several issues with the wiring that were identified and corrected by Battelle's electrical subcontractor. Some of the issues were considered "re-work" and correction of the problems was covered under the service supplier's warranty. Approximately 96% of the I/O has been tested and is functioning correctly (includes checking terminations, addressing within the programmable logic controller (PLC), and ensuring functionality of devices).

Approximately 10% of the loop tuning (optimizing the subroutines within the process) has been completed. During tuning, several issues were identified and are being corrected. The issues were mainly related to system leaks, materials failures, and instrument failures.

Figure 18. Five Creare Cells Mounted on the CBART Fixture.

Battelle conducted startup of the tempered water system in August 2010. The Tempest™ unit is operating as advertised. Battelle completed shakedown of the three tempered water circuits. Several small adjustments were required to ensure tight containment of the glycol solutions. All circuits are functional.

Initial startup of the blower indicated that the blower electrical circuitry is properly connected and controllable with the process logic controller. Shakedown of the blower unit was completed. DI system installation was completed and the system is running properly.

Task 4, Phase IIIA. c. Integrate Subcomponent Items. No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing. No progress made during this reporting period.

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.
Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.
Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. Phase IIIC. b. Construct Sample Train. Battelle completed early testing of the NRT analytical sampling train and determined that as currently configured, the low end sensitivity is 0.25 ng/min or better — 33 times lower than the CBART threshold requirement. In addition to meeting sensitivity requirements, it is critical that the analytical sampling train provide consistent results between the 16 valve ports, 10 of which correspond to the 10 Creare cell sampling positions.

Figure 19 shows early results of the comparisons between eight of the valve ports. Within each set of five replicates per valve position, the relative standard deviation (RSD) was between 1.6 and 4.1%. The overall RSD between the ports (n = 240) was 6%. In addition to port variability, Battelle also examined carry over between ports. In a similar experiment, the eight even-numbered sample ports were challenged (n = 30 per port) and the odd-numbered ports were not challenged (blanks). The unchallenged ports were analyzed to determine if there was any carry over. The carry over from sample to blank ranged from 0.43 to 0.62% (data not shown). The repeatability on each sample port has been further reduced to ~2% on average and the port-to-port high-to-low percent difference reduced to 15%. These data were collected using both the A and B cold trap on the Markes system, so it provided both a worst case and a realistic analysis scenario. Work continues in this area.

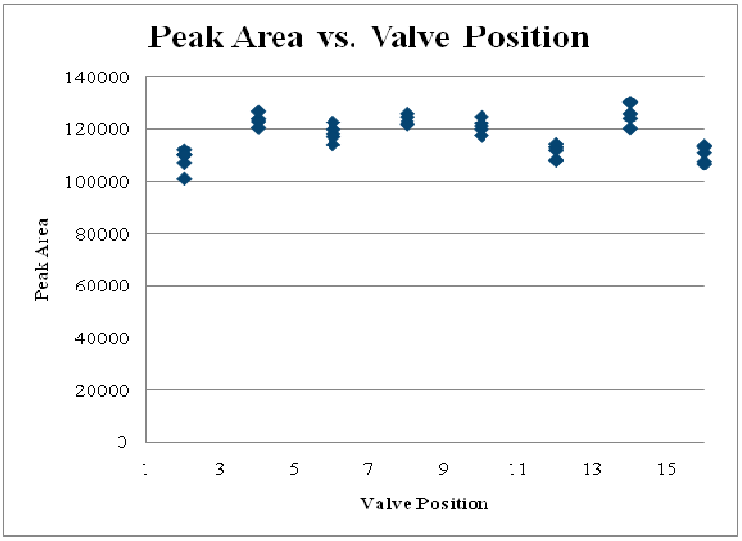


Figure 19. Comparison of Sample Recovery between Even Numbered Valve Positions (n=5 per valve position)

Additional modifications have been made to further reduce the port-to-port difference. The makeup air computer macro that drives the makeup MFC was rewritten to trigger off the initiation and cessation of the Markes sampling. Initial testing of the new macro shows excellent tracking performance now.

Battelle also completed the first round of agent droplet dispenser testing using water and a 70% glycol/30% water solution that has a viscosity similar to VX. Battelle determined that the optimum pressure for delivery was 8 pounds per square inch (psi). At 8 psi, the average RSD was 0.41% between measurements at a particular resistance (Figure 20).

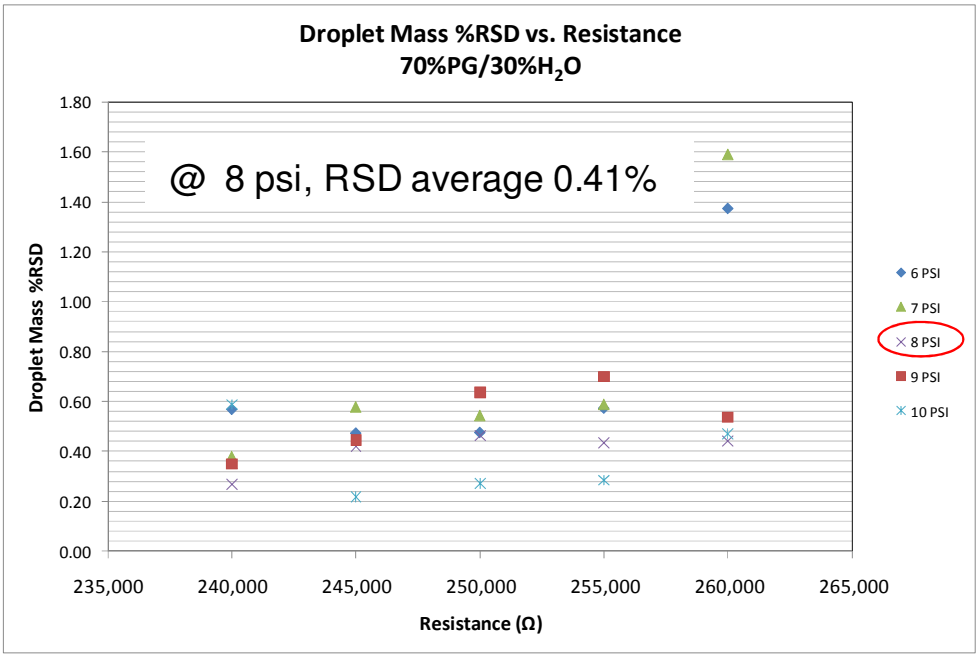


Figure 20. Mass Measurements for Simulant Droplets Dispensed at Different Pressures

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4, Phase IIIE. a. Test Plan Modification. Battelle delivered a third revision of the CBART plan on September 30, 2010. This submission included individual test plans for several of the subsystems.

Task 4, Phase IIIE. b. System Performance Testing (Non-Agent Challenge). No progress made during this reporting period.

Task 4, Phase IIIE. c. System Performance Testing (Swatch Permeation with Simulant). No progress made during this reporting period.

Task 4, Phase IIIE. d. System Performance Testing (Swatch Permeation). No progress made during this reporting period.

Task 4, Phase IIIE. e. Data Reduction and Delivery. No progress made during this reporting period.

Task 4, Phase IIIE. f. Independent Data Review Support. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

8.3 Other Key Events

Battelle conducted a detailed site visit and update brief of the CBART fixture and support equipment for Dr. Charles Bass, Senior S&T Program Manager for Protection and Hazard Mitigation and several other key stakeholders on August 17, 2010.

Battelle received notification that CBART was selected for a platform presentation during the 2010 CB Defense S&T Conference in November 2010.

Battelle provided program updates to DTRA in preparation for the swatch summit held in September 2010.

9.0: FIRST QUARTER FY11 PROGRESS (OCTOBER 1, 2010 – DECEMBER 31, 2010) and SECOND QUARTER FY11 PROGRESS (JANUARY 1, 2011 – FEBRUARY 15, 2011)

9.1 Summary of Work Performed

Battelle completed the fabrication of the test system. In addition, Battelle nearly completed all of the leak testing and resolving leaks up through the test cells. The subcontractors finished installing all of the support instrumentation (outside of the hoods) at the HMRC. The subcontractors also assisted with the replacement/installation of several faulty pieces of equipment. Battelle installed and configured the data historian and continued with shakedown testing and systemization of the test system, to include starting to verify that the system performs as designed. Considerable progress was made towards the proportional intergral derivative (PID) tuning. The CBART NRT analytical system was developed, moved, replumbed, and electrically installed into the CBART lab. Within-port and between-port variability in main sample train was reduced to ~5%, with carry over measured at about 0.8%. System performance was optimized for cooler temperatures in the lab, which resulted in reducing the run cycle time to 2.88 minutes (500 cycles/24 hours). Battelle completed adjudication of comments to the third draft of the CBART Verification Test Plan, edited the document to address the comments, and added eight appendices which included five additional subsystem test plans.

9.2 Detailed Work Performed by SOW Element

Task 4, Phase IIIA. a. Complete Fabrication of Test System. Battelle completed the fabrication of the test system. In addition, Battelle began working to ensure that the completed fixture will meet all safety and ergonomic requirements for use in the facility and to make necessary design modifications in order to meet the safety and operational requirements. System leak testing and resolving leaks up through the test cells is 95% complete. Bruner Corporation removed, leak tested, and repaired the blower filter housing.

Task 4, Phase IIIA. b. Install CBART Prototype.
Subcontractors: Dublin Technical Systems and Sauer Engineering (both small business service providers) finished all of the support instrumentation (outside of the hoods) at the HMRC. In addition, Dublin Technical Systems completed running all of the wire to the control panel and all terminations were completed. Dublin Technical Systems also completed the addition of DC fuses. Sauer Engineering replaced two three-way valves.

Battelle: Installed and configured the data historian. Cleaned up and organized all interior wiring in the main fixture hood. Ran the Teflon® lines leading to the differential pressure transmitters. Ran Teflon® temporary lines over to the MFCs. Assembled both the operator and analytical work stations. Installed the three M-98 filters. Battelle also completed the following maintenance tasks during this time period:

i. Tempered water system Air HX not responding to SP when trying to lower temperature. Power cycle to controller/pump seems to reset. Replaced temperature controller.
ii. Tempered water system compressor was not able to start properly due to a faulty flow switch. Replaced switch.
iii. Replaced level sensors on system.
iv. Re-piped main fixture drain plumbing to better drain.
v. Replaced two grounded thermocouples with ungrounded on the main fixture.
vi. Replaced insulation that was removed as a result of leak repairs.

Task 4, Phase IIIA. c. Integrate Subcomponent Items: No progress made during this reporting period.

Task 4, Phase IIIA. d. Conduct Shake Down Testing: Battelle continued with shakedown testing and systemization of the test system:

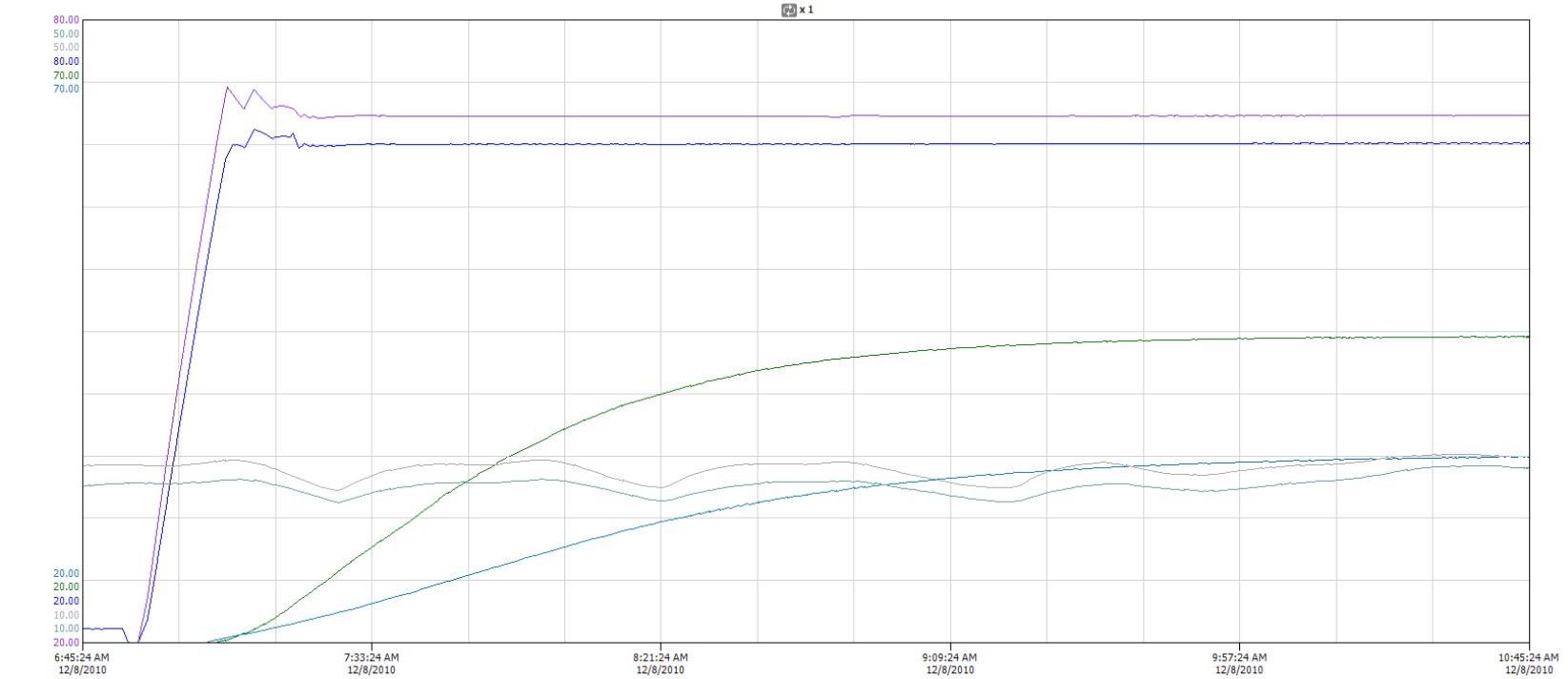
- Temperature, pressure, and velocity control components are all operational.
- Starting to verify that system performs as designed.
- Verified that air flow meets wind speed. System was operated in manual mode to achieve upper wind speed requirement of 3.2 m/s (7 mph) at the following pressure and temperature extremes:
  - Sea level atmospheric pressure and 0°C
  - Sea level atmospheric pressure and 50°C
  - 10,000 ft elevation pressure and 0°C
  - 10,000 ft elevation pressure and 50°C

Notes:

  - Temperature difference across test cells met criteria
  - Pressure drops across the system are higher than calculated and the blower is close to motor capacity to meet these extremes. There is an issue with the flow conditioning screens in each test cell that Creare is working to resolve.

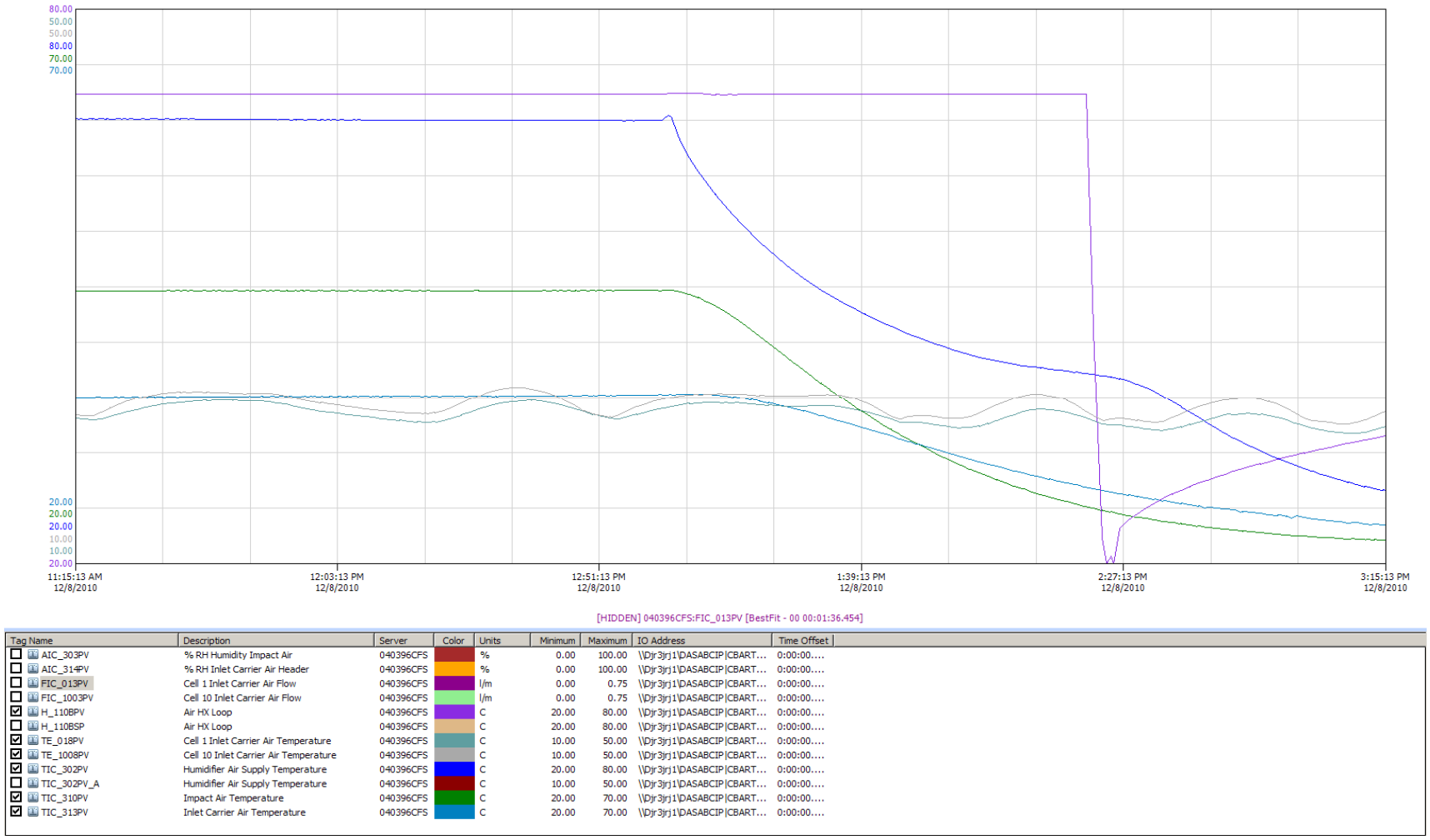
- Verified that swatch impact air temperature set point and control meet requirements.
- PID tuning is 35% complete (includes both Stage 1 and Stage 2). Only another 10% more work can be carried out until additional modifications on the system are completed.
- Created an human machine interface (HMI) graphics page that shows all of the cell process variables graphically between cells.
- System is measuring pressure and flow, but results vary across the system.
- Ran temperature and pressure characterization tests to assist with redesign of the system elements that do not meet spec.

Figures 21 and 22 are screen shots from the data historian where a test was run to investigate the temperature response of impact and carrier air to 45 °C set point. The test revealed that the heat up time is around 2 hours for the impact air and the carrier air will not reach more than about 35 °C; there is little, if any, heating at the cell probe on the carrier air.



Tag Name	Description	Server	Color	Units	Minimum	Maximum	IO Address	Time Offset
☐ AIC_303PV	% RH Humidity Impact Air	040396CFS		%	0.00	100.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☐ AIC_314PV	% RH Inlet Carrier Air Header	040396CFS		%	0.00	100.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☐ FIC_013PV	Cell 1 Inlet Carrier Air Flow	040396CFS		l/m	0.00	0.75	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☐ FIC_1003PV	Cell 10 Inlet Carrier Air Flow	040396CFS		l/m	0.00	0.75	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☑ H_110BPV	Air HX Loop	040396CFS		C	20.00	80.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☐ H_110BSP	Air HX Loop	040396CFS		C	20.00	80.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☑ TE_018PV	Cell 1 Inlet Carrier Air Temperature	040396CFS		C	10.00	50.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☑ TE_1008PV	Cell 10 Inlet Carrier Air Temperature	040396CFS		C	10.00	50.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☑ TIC_302PV	Humidifier Air Supply Temperature	040396CFS		C	20.00	80.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☐ TIC_302PV_A	Humidifier Air Supply Temperature	040396CFS		C	10.00	50.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☑ TIC_310PV	Impact Air Temperature	040396CFS		C	20.00	70.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....
☑ TIC_313PV	Inlet Carrier Air Temperature	040396CFS		C	20.00	70.00	\\Djr3jrj1\DASABCIP\CBART...	0:00:00....

Figure 21. Data Historian Screen Shot – Impact Temperture Response



Tag Name	Description	Server	Color	Units	Minimum	Maximum	IO Address	Time Offset
☐ AIC_303PV	% RH Humidity Impact Air	040396CFS		%	0.00	100.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☐ AIC_314PV	% RH Inlet Carrier Air Header	040396CFS		%	0.00	100.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☐ FIC_013PV	Cell 1 Inlet Carrier Air Flow	040396CFS		l/m	0.00	0.75	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☐ FIC_1003PV	Cell 10 Inlet Carrier Air Flow	040396CFS		l/m	0.00	0.75	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☑ H_110BPV	Air HX Loop	040396CFS		C	20.00	80.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☐ H_110BSP	Air HX Loop	040396CFS		C	20.00	80.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☑ TE_018PV	Cell 1 Inlet Carrier Air Temperature	040396CFS		C	10.00	50.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☑ TE_1008PV	Cell 10 Inlet Carrier Air Temperature	040396CFS		C	10.00	50.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☑ TIC_302PV	Humidifier Air Supply Temperature	040396CFS		C	20.00	80.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☐ TIC_302PV_A	Humidifier Air Supply Temperature	040396CFS		C	10.00	50.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☑ TIC_310PV	Impact Air Temperature	040396CFS		C	20.00	70.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…
☑ TIC_313PV	Inlet Carrier Air Temperature	040396CFS		C	20.00	70.00	\\Djr3jrj1\DASABCIP\CBART…	0:00:00.…

Figure 22. Data Historian Screen Shot – Carrier Air Temperture Response

Task 4, Phase IIIA. e. Conduct Test Readiness Review. No progress made during this reporting period.

Task 4, Phase IIIB. a. Conduct System Analysis. No progress made during this reporting period.

Task 4, Phase IIIB. b. Convene a Peer Review. No progress made during this reporting period.

Task 4, Phase IIIB. c. Design Sample Train. No progress made during this reporting period.

Task 4, Phase IIIB. d. Develop Interface Control Document. No progress made during this reporting period.

Task 4, Phase IIIB. e. Develop Sampling System Standard Operating Procedures. No progress made during this reporting period.

Task 4, Phase IIIC. a. Development Plan. No progress made during this reporting period.

Task 4. IIIC. b. Construct Sample Train. The CBART NRT analytical system was moved, plumbed, and electrically installed into the CBART lab (Figure 23). Within-port and between-port variability in the main sample train reduced to ~5%. System performance was optimized for cooler room temperatures, reducing run cycle time to 2.88 minutes (500 cycles/24 hours). Heated transfer line final layout design was completed, and quotes were obtained for purchase; the purchaseis ready to be executed. Ordered and received the zero air generator.

Figure 23. CBART NRT Analytical System

Task 4, Phase IIIC. c. Sampling Train Verification Test Plan. No progress made during this reporting period.

Task 4, Phase IIIC. d. Sampling Train Verification Testing. No progress made during this reporting period.

Task 4. Phase IIIE. a. Test Plan Modification. Battelle completed adjudication of comments to the third draft of the CBART Verification Test Plan. Very few comments have been received and these will be addressed in the final draft of the test plan that will incorporate the detailed step-by-step operating procedures for fixture operation.

Task 4, Phase IIIE. b. System Performance Testing (Non-Agent Challenge). No progress made during this reporting period.

Task 4, Phase IIIE. c. System Performance Testing (Swatch Permeation with Simulant). No progress made during this reporting period.

Task 4, Phase IIIE. d. System Performance Testing (Swatch Permeation). No progress made during this reporting period.

Task 4, Phase IIIE. e. Data Reduction and Delivery. No progress made during this reporting period.

Task 4, Phase IIIE. f. Independent Data Review Support. No progress made during this reporting period.

Task 4, Phase IIIF. a. Non-traditional Agent Feasibility Study. No progress made during this reporting period.

9.3 Other Key Events

Battelle and team members held an internal independent design review. Conclusions from this design review included:

i. Highly complex, first of kind system
ii. System looks good on paper and in hardware
iii. Insufficient funds to complete project
iv. Schedule was optimistic

Recommendations of the design review included:

i. Add part-time system engineer
ii. Add part-time mechanical engineer
iii. Bring operator into the system now rather than later
iv. Hire temporary control system programmer and use split shifts to accelerate PID tuning schedule
v. Use of detailed punch list to monitor progress and track costs
vi. Management review at weekly meetings
vii. Update punch list with % complete
viii. Compare labor and materials estimates to actuals
ix. Monthly earned value management reporting to DTRA
x. More frequent dialogue with DTRA on technical issues and potential impact on performance

Battelle held a CBART status meeting with the entire Battelle team and Dr. Charles Bass and William Buechter of DTRA. The objective of this meeting was to update DTRA on all work to date, all future work, discuss any significant issues/risks, and determine how much funds would be required to get to the TRR and to complete all the testing.

9.4 Path Forward

Complete the remaining 25% of fixture troubleshooting. Install parts, verify the modifications are effective, and retune loops affected by modifications. Begin the NRT analytical system carryover evaluation and resolution work.